Department of Computer Science

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The Department of Computer Science offers a program leading to the degree of Master of Science (MS) in Computer Science. For more information about the department, visit https://website.aub.edu.lb/fas/cs/Pages/index.aspx.

Mission Statement

The department of Computer Science at the American University of Beirut prepares students for advanced studies and professional careers in the dynamically changing world of computing and information technology. Our programs combine the theoretical foundations of computing with the practical knowledge of software development vital to industry, to provide broad and integrated curriculums.

The department offers a Bachelor of Science (BS) degree in computer science, designed to be completed typically in three years. It also offers a Master of Science (MS) program designed to provide advanced and specialized education in computing, offered in formats that meet the needs of both working professionals and full-time students.

The department has vigorous research programs in theoretical computer science networking and security, machine learning and data science, high-performance computing, data mining and information retrieval, and software engineering. Our faculty members are committed to contributing to the advancement of the field of computing through scholarly activities, in which our students play a vital role.

MS in Computer Science

In addition to the university requirements for graduate study in the Faculty of Arts and Sciences, students must complete: (1) 21 credits and a thesis (thesis option), (2) 27 credits and a project (project option), or (3) 30 credits of course work (course-based option). For all options, the student must take 3 credits from each of the following 3 categories (9 credits in total): theory, systems, and applications. The remaining credits (12 for the thesis option, 18 for the project option, and 21 for the course-based option) are normally CMPS courses numbered 300 and above to be taken in coordination with the student's advisor. For more information about the program, visit https://website.aub.edu.lb/fas/cs/Pages/index.aspx.

Course Descriptions

CMPS 314 Design and Analysis of Algorithms 3.0; 3 cr.
A course that studies advanced data structures and algorithms, with an emphasis on the design of algorithms. Topics include advanced graph and search algorithms, dynamic programming, amortized analysis, parallelism, greedy and approximate algorithms, string and pattern matching, computational geometry and an introduction to the class of NP-complete problems. *This course was previously numbered CMPS 356. Annually.*

CMPS 315 Complexity Theory 3.0; 3 cr.
Complexity theory studies the power and limitations of efficient computation. It addresses questions related to what can be computed when we bound resources such as time, memory, randomness, communication, and parallelism. These questions are generally widely open and many surprising connections exist between them. Topics include randomized algorithms, bounded-space algorithms, Savitch's Theorem, Immerman-Szelepcsényi's Theorem, the PCP Theorem and its connections to hardness of approximation, interactive proofs and IP = PSPACE, hardness vs. randomness, hardness amplification, introduction to parameterized complexity, circuit complexity, and hardness within P. Prerequisite: Consent of Instructor.

CMPS 316 Algorithmic Graph Theory 3.0; 3 cr.
Algorithmic graph theory is a central area that lies at the intersection of mathematics and computer science. At the heart of it are graphs, which are mathematical structures that are used to model relations between objects, together with algorithms used to manipulate these models. Algorithmic graph theory is used to model many types of relations and dynamics in physical, biological, and even social systems. This course helps students develop the mathematical underpinnings of the theory of graphs and graph algorithms by providing an introduction to an exciting area having applications in many fields including mathematics, computer science, engineering, physics, biology, economics, and many others. Prerequisite: Consent of Instructor.

CMPS 323 Parallel Computing 3.0; 3 cr.
A course that discusses the design, analysis and implementation of algorithms for parallel computers. Topics include selection, merging, sorting, searching, matrix computations, numerical problems and fast fourier transforms. Students develop skills in designing parallel algorithms and analyzing their asymptotic running time and memory requirements, and develop medium-sized parallel codes using modern languages and libraries. *This course was previously numbered CMPS 373. Annually.*

CMPS 332 Compiler Construction 3.0; 3 cr.
Graduate students may be required to do extra reading, a term paper and/or an additional project.*Same as CMPS 232. This course was previously numbered CMPS 374. Annually.*

CMPS 342 Advanced Computer Networks 3.0; 3 cr.
This course enhances students' knowledge about up-to-date networking topics and improves their research skills in the field. It reviews the major protocols of TCP/IP stack then introduces modern Internet routing, IP multicasting, quality of service, Internet telephony, IPv6, MPLS, etc. The course also covers the architectures of wireless local area networks (IEEE 802.11), mobile IP networks, Mobile Ad hoc Networks (MANETS),

GSM and its evolution to UMTS then LTE, Internet of Things and Wireless Sensor Networks. Although the course is a lecture-based course, discussions are always encouraged. To prepare you to conduct independent research, the course contains a term research project in which students working in small groups select a related research topic to survey, identify existing problems, and try to propose solutions. *This course was previously numbered CMPS 384. Annually.*

CMPS 345 Distributed Systems 3.0; 3 cr.
A distributed system consists of a set of nodes located at networked computers and communicate only by passing messages. This course provides techniques to abstract, design and implement efficient, scalable and fault-tolerant distributed systems. Topics include, but are not limited to, inter-process communication, distributed synchronization and consensus (e.g., paxos, blockchain), fault-tolerance, distributed file systems (e.g., HDFS), and Hadoop ecosystem. *This course was previously numbered CMPS 375. Annually.*

CMPS 350 Discrete Models for Differential Equations 3.1; 3 cr.
A detailed study of methods and tools used in deriving discrete algebraic systems of equations for ordinary and partial differential equations: finite difference and finite element discretization procedures; generation and decomposition of sparse matrices, finite-precision arithmetic, ill-conditioning and pre-conditioning, Scalar, vector and parallelized versions of the algorithms. The course includes tutorial "immersion" sessions in which students become acquainted with state-of-the-art scientific software tools on standard computational platforms. *Prerequisites: Linear algebra and the equivalent of MATH/CMPS 251 (which can be taken concurrently) or upon consent of the instructor. Same as MATH 350. Occasionally.*

CMPS 351 Optimization and Nonlinear Problems 3.1; 3 cr.
A study of practical methods for formulating and solving numerical optimization problems that arise in science, engineering and business applications. Newton's method for nonlinear equations and unconstrained optimization. Simplex and interior-point methods for linear programming. Equality and inequality-constrained optimization. Sequential quadratic programming. Emphasis is on algorithmic description and analysis. The course includes an implementation component where students develop software and use state-of-the-art numerical libraries. *Same as MATH 351. Annually.*

CMPS 354 The Finite Element Method 3.0; 3 cr.
A course that presents the theoretical foundations of the finite element method and some of its applications to partial differential equations. Topics include Sobolev spaces, existence and uniqueness of weak solutions and the Lax-Milgram lemma, regularity of weak solutions and a priori estimates, the Galerkin method, piecewise polynomial approximations, approximating solutions of boundary value problems for elliptic equations, and initial value problems for parabolic and hyperbolic equations. *Occasionally.*

CMPS 358 Introduction to Symbolic Computing 3.0; 3 cr.
Introductory topics in computer algebra and algorithmic number theory that include fast multiplication of polynomials and integers, fast fourier transforms, primality testing and integers factorization. Applications to cryptography and pseudo-random number generation. Linear algebra and polynomial factorization over finite fields. Applications to error-correcting codes. Introduction to Grobner bases. *Same as MATH 358. Occasionally.*

CMPS 359 Special Topics in Computational Science 3.0; 3 cr.
A course on selected topics in computational science, which change according to the interests of visiting faculty, instructors and students. Selected topics cover state-of-the-art tools and applications in computational science. *May be repeated for credit. Prerequisite: Consent of instructor.Same as MATH 360. This course was previously numbered CMPS 360. Occasionally.*

CMPS 364 Advanced Machine Learning 3.0; 3 cr.
This course focuses on Deep Learning and its applications. Deep Learning has revolutionized the field of Machine Learning and has turned Artificial Intelligence from a research endeavor into an actual reality. In this course, students will learn about the fundamentals of Deep learning, and how to build Deep Learning models for various real-world applications, particularly in Computer Vision and Natural Language Processing. *This course was previously numbered CMPS 392. Annually.*

CMPS 365 Information Retrieval and Web Search 3.0; 3 cr.
This course introduces graduate-level students to the basics of information retrieval, and the models and algorithms underlying modern search engines. Topics covered include: crawling; indexing; Boolean and vector space retrieval models; probabilistic information retrieval models; language models; top-k query processing; evaluation of information retrieval systems; relevance feedback; link analysis; latent semantic analysis; and information extraction. *This course was previously numbered CMPS 391 Occasionally.*

CMPS 371 Advanced Software Engineering 3.0; 3 cr.
A course on state-of-the-art software engineering for large distributed and concurrent systems. Fundamental principles and concepts for specifying, designing, analyzing, implementing and testing such systems. Concurrent object oriented paradigms. Design patterns. Use of tools. Documentation using both formal and informal descriptions. *Students will develop at least one large software system as part of the course. This course was previously numbered CMPS 363. Annually.*

CMPS 385 Advanced Computer Graphics 3.0; 3 cr.
A course that presents the basic concepts of 3D computer graphics. Topics include 3D object representations and manipulations, 3D transformation and viewing, hidden-surface and hidden-line removal, shading models, rendering, texture mapping, ray-tracing and animation techniques. *Occasionally.*

CMPS 386 Computer-Aided Geometric Design 3.0; 3 cr.
Graduate students taking the course are assigned extra work in the form of outside reading, a term paper and/or an additional project. *Same as CMPS 286. Occasionally.*

CMPS 388 Computer Animation 3.0; 3 cr.
A course that introduces the basic techniques and algorithms in computer animation. Topics include: history and applications of computer animation, modeling, interpolation, key framing, morphing, deformation, forward and inverse kinematics, particle systems and rigid body dynamics. *Occasionally.*

CMPS 395A Comprehensive Exam 0 cr.
Prerequisite: Consent of advisor.

CMPS 396 Special Topics in Computer Science 1 - 3 cr.
A course in which topics may vary each term and are expected to be in areas of active research. Students may register for this course twice (or more) on condition that course content differs. *May be repeated for credit. Prerequisite: Consent of instructor. Annually.*

CMPS 397 Tutorial 1 - 3 cr.
May not be repeated for credit.

CMPS 398 Project 3 cr.

CMPS 399 Thesis 9 cr.