

# Department of Computer Science

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Lecturer:	<sup>P</sup> Ladan, Mohamad I.
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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 its webpage at <http://www.cs.aub.edu.lb/>.

## Graduate Program

### MS in Computer Science

In addition to the university requirements for graduate study in the Faculty of Arts and Sciences, students must complete 24 credits and a thesis (thesis option), or 30 credits and a project (project option), as detailed below. For both options the student must take 12 credits: one course from each of the four categories: Theory, Systems, Software and Applications, as listed in <http://wwwlb.aub.edu.lb/~webmcs/>. These courses are as follows: CMPS 356 or CMPS 357; CMPS 371, CMPS 372, CMPS 373, or CMPS 374; CMPS 363 or CMPS 366; CMPS 377, CMPS 385, or CMPS 393. Additional courses in each of these categories could be offered/considered by the department. The remaining credits (12 for the thesis option and 18 for the project option) are to be taken in coordination with the student's adviser. For more information about the program, visit <http://www.cs.aub.edu.lb/> and <http://wwwlb.aub.edu.lb/~webmcs/>.

## Graduate Courses

### 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. *Prerequisite: linear algebra and the equivalent of MATH/CMPS 251 (which can be taken concurrently) or consent of the instructor. Same as MATH 350. Annually.*

### CMPS 351 Optimization and Non-Linear 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. *Prerequisite: MATH/CMPS 350 or consent of the instructor. 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. *Prerequisites: CMPS 251 and MATH 218 or MATH 219. Biennially.*

### CMPS 356 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. *Prerequisite: CMPS 256 or graduate standing. Annually.*

### CMPS 357 Complexity Theory 3.0; 3 cr.

A course that discusses complexity classes of algorithms, especially those arising from time and space analysis of bounded computations. Topics include sequential, deterministic, parallel, and non-deterministic models of computation, the Turing machine model, the class NP, questions of completeness and reducibility, and the hierarchy of complexity classes. *Prerequisite: CMPS 257 or graduate standing. Annually.*

### 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. *Prerequisite: Good background in programming, linear algebra, discrete mathematics or consent of instructor. Same as MATH 351. Annually.*

**CMPS 360 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. *Prerequisite: Consent of instructor. Same as MATH 360. Annually.*

**CMPS 363 Software Engineering 3.0; 3 cr.**

A course that studies techniques that facilitate the definition and development of reliable software systems. Topics include developing system requirements, requirement analysis, formulation of system architecture, establishing a detailed design, system integration, testing, and delivery. *Prerequisite: CMPS 282 or graduate standing. Annually.*

**CMPS 366 Object-Oriented Software Development Methods 3.0; 3 cr.**

An introduction to object-oriented methods for the systematic development of software systems and reusable components. Topics include object-oriented life cycles, analysis and design techniques such as object modeling and event traces and their application using case tools, approaches for evolving designs into implementations, and management issues in applying object-oriented technologies and in controlling projects effectively. *Prerequisite: CMPS 282 or graduate standing. Annually.*

**CMPS 367 Object-Oriented Technology 3.0; 3 cr.**

A course on advanced topics in object-oriented technology with in-depth treatment of design patterns, frameworks, concurrent, and distributed computing. *Prerequisite: CMPS 366 or consent of instructor. Annually.*

**CMPS 368 Programming Language Design 3.0; 3 cr.**

A course that studies unconventional and modern concepts of programming languages. Topics include concepts of exception handling, higher order functions and recursion, concurrent programming, mutual exclusion and synchronization, message passing, monitors, and support for concurrency control. *Prerequisite: CMPS 258 or graduate standing. Annually.*

**CMPS 371 Advanced Computer Architecture 3.0; 3 cr.**

A course that discusses the structure of computer systems using processors, memories, input/output devices, and interfaces as building blocks. Topics include computer system instruction set design and implementation, memory hierarchies and pipelining, issues and tradeoffs involved in the design of computer system architectures with respect to the design of instruction sets, and parallelism and its exploitation in specific machines such as hypercubes and transputers. *Prerequisite: CMPS 255 or graduate standing Annually.*

**CMPS 372 Advanced Operating Systems 3.0; 3 cr.**

A course that discusses advanced topics in OS with an exposure to distributed systems. Topics include virtual memory management, synchronization and communication, protection and security, operating system extension techniques, distributed and parallel systems, and modification of an existing operating system. *Prerequisite: CMPS 272 or graduate standing. Annually.*

**CMPS 373 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. *Prerequisites: CMPS 255 and CMPS 256 or graduate standing. Annually.*

**CMPS 374 Compiler Construction 3.0; 3 cr.**

Same as CMPS 274. Graduate students taking the course are expected to do extra reading, a term paper and/or an additional project. *Prerequisites: CMPS 255, CMPS 257 or consent of instructor. Annually.*

**CMPS 377 Internals of Database Management Systems 3.0; 3 cr.**

Same as CMPS 288. Graduate students taking the course are assigned extra work in the form of outside reading, a term paper and/or an additional project. *Prerequisite: CMPS 277 or graduate standing. Annually.*

**CMPS 378 Advanced Database Applications 3.0; 3 cr.**

A course on advanced topics in database systems and their applications. Topics are chosen from object databases, data mining, schema evolution, distributed databases, web enabled databases, and databases for e-commerce applications. *Prerequisite: CMPS 277 or graduate standing. Annually.*

**CMPS 384 Advanced Computer Networks 3.0; 3 cr.**

This course examines advanced topics in computer networks such as routing on the Internet, IP multicasting, quality of service, Internet telephony, IPv6, MultiProtocol Label switching (MPLS), network performance, network security, overlay networks, etc. The course covers also the architectures and main components of wireless local area networks (IEEE 802.11), Mobile IP Networks, Mobile Ad hoc Networks (MANETS), and WiMax networks (as defined in IEEE 802.16 standard). Some other topics may be covered through students' research projects, presentations, and assigned reading. The course starts by presenting a quick overview of the major protocols of TCP/IP stack. *Prerequisite: CMPS 284 or consent of instructor. 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. *Prerequisite: CMPS 285 or consent of instructor. Annually.*

**CMPS 386 Computer-Aided Geometric Design 3.0; 3 cr.**

Same as CMPS 286. Graduate students taking the course are assigned extra work in the form of outside reading, a term paper and/or an additional project. *Prerequisite: CMPS 285 or consent of instructor. Annually.*

**CMPS 387 Data Visualization 3.0; 3 cr.**

A course on techniques in visualizing scientific and other types of data. Topics include a review of computer graphics fundamentals, 2D and 3D data types, differential operators and metric spaces, visualization for 2D and 3D data sets, physical models, methods of computational science, visualization schemes for scalar, vector, and other types of data, ISO-surface and volume visualization, visual monitoring, and interactive steering. *Prerequisite: CMPS 385 or graduate standing. Annually.*

**CMPS 392 Knowledge Representation and Reasoning under Uncertainty 3.0; 3 cr.**

Deductive logic as a tool for formal reasoning in AI and its limitations; probability theory as another tool for this purpose; emphasis on Bayesian belief networks, a technology for expert system applications such as medical diagnosis; syntax semantics and inference algorithms for Bayesian belief networks, in addition to extensions concerning reasoning over time and planning under uncertainty. *Prerequisite: CMPS 287 or consent of instructor. Annually.*

<b>CMPS 393</b>	<b>Building AI Systems</b>	<b>3.0; 3 cr.</b>
Key algorithms for building AI systems; algorithms for searching, backward and forward chaining, production-rule systems, truth maintenance, reasoning with uncertainty, and constraint satisfaction; application areas including diagnosis, temporal reasoning, and planning. <i>Prerequisite: CMPS 287. or consent of instructor. Annually.</i>		
<b>CMPS 394</b>	<b>Computer Arabization</b>	<b>3.0; 3 cr.</b>
A course that discusses issues and techniques that arise in computer Arabization. Topics include Arabic text editing, morphology, information retrieval, language comprehension, spelling and grammar checking, WWW browsers, and computer-aided education. <i>Prerequisite: Consent of instructor. Biennially.</i>		
<b>CMPS 395</b>	<b>Subdivision for Modeling and Animation</b>	<b>3.0; 3 cr.</b>
A course on subdivision surfaces and their use in geometric modeling and animation. Topics include polar form of Bezier and B-splines curves and surfaces; subdivision curves; subdivision surfaces; analysis of limit curves and surfaces; Subdivision for Modeling: shape control, interpolation, digitizing and designing objects; Basic Animation and Subdivision: key framing, free-form deformation, morphing, warping, particle systems. <i>Prerequisite: CMPS 285 or consent of instructor. Annually.</i>		
<b>CMPS 395A/ 395B Comprehensive Exam</b>		<b>0 cr.</b>
<i>Prerequisite: Consent of adviser.</i>		
<b>CMPS 396</b>	<b>Special Topics in Computer Science</b>	<b>1 - 3 cr.</b>
A course in which topics may vary each semester and are expected to be in areas of active research, such as computer-aided geometric design, databases, object orientation, and artificial intelligence. Students may register for this course twice (or more) on condition that course content differs. <i>Prerequisite: Consent of instructor. Annually.</i>		
<b>CMPS 397</b>	<b>Computer Science Tutorial</b>	<b>1 - 3 cr.</b>
<b>CMPS 398</b>	<b>MS Project</b>	<b>0 Credit</b>
<b>CMPS 399</b>	<b>MS Thesis</b>	<b>6 cr.</b>