COMPUTER SCIENCE - PROFESSIONAL MASTER OF SCIENCE (MSCPS)

The Professional Master of Science (MSCPS) is a degree program that offers possibilities for a wide range of students. Whether the student is a working engineer or an undergraduate considering a career in industry, there are program options to meet their needs.

The department offers seven degree tracks, each of which result in a Professional Master of Science in Computer Science:

1. General
2. Algorithms, Network and Optimization
3. Data Science and Engineering
4. Human-Centered Computing
5. Intelligent Systems
6. Numerical Computation
7. Robotics
8. Software Systems and Cloud Computing

The Department of Computer Science has embraced this degree as an ideal opportunity to expand the high quality courses in the fields above into a wide array of courses leading to a full master's degree. The goal of the MSCPS program is to produce creative, workforce-ready graduates equipped with versatile specialized skills and technical leadership.

Adding several new subplan courses to the program now enables greater options for earning professional MS degree with a these subplans, while also offering plenty of courses to complete a full master's degree, principally with a subplan focus. Students pursuing this degree will also have access to many excellent graduate-level courses offered by the department's highly reputed faculty.

Subplans

General Track

Students opting for this track have the option to select classes from an approved list for the degree. The jobs these students get are also similar to other subplans. However, specializing in a subplan is more beneficial.

Algorithms, Network and Optimization

The subplan enables students to employ powerful mathematical tools and techniques from algorithms, graph theory, computational complexity theory and mathematical optimization to solve problems that may arise in research and development of cutting edge computing systems. Skills include: design and analysis of algorithms, understanding inherent problem complexity and deploying optimization-based tools and techniques. We expect graduates to fill software development roles with an emphasis on algorithms design, data analysis and solution design.

Potential job titles include: graph theorist, optimization analyst, software developer on algorithms design and data analysts on algorithms design. Potential employers include Twitter, Google, Facebook, Amazon, Oracle, Uber, Microsoft and Apple.

Data Science and Engineering

This subplan provides the skills to develop computer solutions that require expertise in data science and engineering. Students who complete the program receive both a master's degree in computer science and a specialization within data science and engineering. This combination is very attractive as technology companies are looking for developers that have experience in data science. Students complete both a set of core courses for the degree in addition to a set of data science courses.

Potential job titles include: Hadoop developer, BI developer, quantitative data engineer, search engineer, technical architect, big data analyst, solutions architect, data warehouse engineer, data science software engineer and ETL developer. Potential employers include Twitter, Google, Facebook, Amazon, Oracle, Uber, Microsoft and Apple.

Human-Centered Computing

In this track, students learn how to design, implement and evaluate user interfaces for a range of computing technology, and gain skills related to designing technologies to support the needs of real people. Topics covered include user-centered design, information visualization, universally accessible design and computer-supported cooperative work. Students will gain experience with the entire user-centered design process, from requirements gathering, prototyping, and qualitative and quantitative user evaluation. Many courses in this concentration are project-based and will involve user-centered research in the lab and in the field.

Potential job titles for graduates of this program include user experience researcher, user interface engineer, data scientist, interaction designer, front-end developer, accessibility specialist, mobile application developer. Potential employers include Facebook, Google, Microsoft, Twitter, Adobe, Autodesk, Sphero, Snap and Oculus.

Intelligent Systems and Robotics

The subplans in intelligent systems and robotics build expertise in algorithms and methods for developing autonomous systems, including robotics and cyber-physical systems. As part of this program, students will design and analyze systems which leverage computation to interact with the world around them through sensors and actuators. Machine learning, signal processing and control theory are all components to this program, where students become experts in creating the software for devices ranging from climate control systems to automobiles.

Potential job titles for graduates of this program focusing on *intelligent systems* include: software engineer, perception engineer, data scientist and research engineer. Potential employers include Lockheed-Martin, Amazon, Microsoft, Google and Facebook.

Potential job titles for graduates of this program focusing on *robotics* include: robotics engineer, perception engineer, control engineer and robotics scientist. Potential employers include: Amazon Robotics, Uber, Google, iRobot and DJI.

Numerical Computation

Ongoing improvements in computational capability and memory performance have increased the importance of high-fidelity simulations, optimization and data-driven science and engineering applications. Students in this subplan develop the skills to design robust and high-performance numerical methods for addressing real-world problems and develop production-grade implementations using state of the art software tools to target modern architectures and large-scale parallel computers.

Potential job titles: Computational scientist/engineer, numerical/data analyst, research scientist, software engineer, HPC developer and

quantitative software engineer. Potential employers include national labs, universities, engineering ISVs (ANSYS, MSC, CD-adapco), aerospace (NASA, Boeing, ULA, SpaceX, Lockheed), exploration (Shell, Schlumberger, CMG), manufacturing (P&G, GE), technology (Amazon, Google, IBM, Motorola) and finance (HFT, mutual funds, credit card).

Software Systems and Cloud Computing

In this subplan, students learn about software systems and how they are applied to real world problems. They'll also discover how emerging cloud computing technologies can be used to implement some of the world's most popular services and applications.

For more information, visit the department's Professional MS Degree Program Requirements (http://www.colorado.edu/cs/current-students/graduate-students/ms-degree/professional-ms-degree-requirements/) webpage.

Bachelor's–Accelerated Master's Degree Program

Students may earn this degree as part of the Bachelor's–Accelerated Master's (BAM) degree program, which allows currently enrolled CU Boulder undergraduate students the opportunity to earn a bachelor's and master's degree in a shorter period of time.

For more information, see the Accelerated Master's tab for the associated bachelor's degree(s):

- Applied Computer Science - Post-Baccalaureate Bachelor of Science (BSACS) (https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/computer-science/applied-computer-science-post-baccalaureate-bachelor-science-bsacs/)
- Computer Science - Bachelor of Arts (BA) (https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/computer-science/computer-science-bachelor-arts-ba/)
- Computer Science - Bachelor of Science (BSCS) (https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/computer-science/computer-science-bachelor-science-bscs/)

Distance Education Option

Students can take individual courses toward a master's degree or graduate certificate through distance education (online). For more information, connect with the individual graduate program directly.

Requirements

Admission Requirements

Applicants for graduate study in computer science must hold at least a bachelor's degree or its equivalent from an accredited institution. They should have programming experience, a number of computer science courses and sufficient mathematical maturity to understand pure mathematics courses at the upper division (junior/senior) level. A minimum undergraduate GPA of 3.0 (on a scale of 4.0) is required for admission to the master's program.

Applicants are *not* required to submit GRE scores.

Mathematics Courses

A student's academic background should include at least three semesters of mathematics at the level of sophistication of calculus or above. Examples of such courses include calculus, differential equations, linear algebra, probability, statistics and abstract algebra. The courses should indicate that the student has achieved the mathematical maturity expected of an upper-level science, engineering or mathematics undergraduate.

Computer Science Courses

At least three one-semester courses in computer science that are beyond the introductory level are required for admissions. These are intended to demonstrate breadth of basic computer science knowledge in the areas of computer hardware, software and theory. The courses should include the equivalent of the following CU Boulder offerings:

- Hardware requirement: CSCI 2400 Computer Systems (Computer Systems)
- Software requirement: Either CSCI 3155 Principles of Programming Languages or CSCI 3753 Design and Analysis of Operating Systems
- Theory requirement: CSCI 2270 Computer Science 2: Data Structures and either CSCI 3104 Algorithms or CSCI 3434 Theory of Computation

Required Courses and Credits

The following requirements are subject to change; for the most current information, visit the department's Professional MS Degree Program Requirements (http://www.colorado.edu/cs/current-students/graduate-students/ms-degree/professional-ms-degree-requirements/) webpage.

Degree Requirements

Students must complete a total of 30 credit hours of approved graduate level course work with a grade of C or better and a cumulative GPA of at least 3.00. Students are allowed to take two non-CS courses and the rest must be CSCI courses. Students under this option are *not* allowed to take research hours or thesis option.

Code	Title	Credit Hours
Breadth Courses		
Students must complete one breadth course from each of the three bins listed below, for a total of 9 credits of breadth courses. Students must earn a grade of B or better in each of the three breadth courses.		
Bin One		
Choose one:		3
CSCI 5229	Computer Graphics	
CSCI 5254	Convex Optimization and Its Applications	
CSCI 5434	Probability for Computer Science	
CSCI 5444	Introduction to Theory of Computation	
CSCI 5446	Chaotic Dynamics	
CSCI 5454	Design and Analysis of Algorithms	
CSCI 5576	High-Performance Scientific Computing	
CSCI 5606	Principles of Numerical Computation	
CSCI 5636	Numerical Solution of Partial Differential Equations	
CSCI 5646	Numerical Linear Algebra	
CSCI 5654	Linear Programming	
CSCI 5676	Numerical Optimization	

Bin Two		
Choose one:		3
CSCI 5302	Advanced Robotics	
CSCI 5322	Algorithmic Human-Robot Interaction	
CSCI 5352	Network Analysis and Modeling	
CSCI 5402	Research Methods in Human-Robot Interaction	
CSCI 5502	Data Mining	
CSCI 5616	Introduction to Virtual Reality	
CSCI 5622	Machine Learning	
CSCI 5722	Computer Vision	
CSCI 5822	Probabilistic Models of Human and Machine Learning	
CSCI 5832	Natural Language Processing	
CSCI 5839	User-Centered Design and Development 1	
CSCI 5849	Input, Interaction, and Accessibility	
CSCI 5922	Neural Networks and Deep Learning	
Bin Three:		
Choose one:		3
CSCI 5135	Computer-Aided Verification	
CSCI 5253	Datacenter Scale Computing - Methods, Systems and Techniques	
CSCI 5273	Network Systems	
CSCI 5403	Cybersecurity	
CSCI 5413	Computer Security and Ethical Hacking	
CSCI 5448	Object-Oriented Analysis and Design	
CSCI 5525	Compiler Construction	
CSCI 5535	Fundamental Concepts of Programming Languages	
CSCI 5573	Advanced Operating Systems	
CSCI 5673	Distributed Systems	
CSCI 5753	Computer Performance Modeling	
CSCI 5854	Theoretical Foundations of Autonomous Systems	
Project Courses		
Complete six credits of projects class from either of the following two options:		6
CSCI 5340 & CSCI 5350	Startup Essentials: Entrepreneurial Projects in Computing and Entrepreneurial Projects II	
CSCI 5040 & CSCI 5050	Professional Masters Project 1 and Professional Masters Project 2	
Additional Coursework		
An additional 15 credits are required to complete the degree, with restrictions. [1]		15
Total Credit Hours		**30**

[1] Additional coursework may consist of no more than two non-CS classes, except for classes under subplans. (Classes listed under required sub-plans will not be considered against the two non-CS.)

Time Limit

All degree requirements must be completed within four years of the date of commencing coursework. Most students complete the degree in two years.

Subplan Tracks

In addition to the above mentioned required courses, students enrolled in any the following subplans must also complete the required subplan courses as listed below.

Students must earn a grade of B or better all subplan courses. Students may count the same course towards their subplan and breadth requirements.

Data Science and Engineering (DSE) (https://www.colorado.edu/cs/data-science-engineering-sub-plan-requirements/)

Code	Title	Credit Hours
Core Courses		
Choose four:		
CSCI 5253	Datacenter Scale Computing - Methods, Systems and Techniques	
CSCI 5502	Data Mining	
CSCI 5622	Machine Learning	
CSCI 5654	Linear Programming	
ATLS 5214	Big Data Architecture	
CSCI 5254	Convex Optimization and Its Applications	
CSCI 5352	Network Analysis and Modeling	
CSCI 5576	High-Performance Scientific Computing	
CSCI 5676	Numerical Optimization	
CSCI 5722	Computer Vision	
CSCI 5832	Natural Language Processing	
CSCI 5922	Neural Networks and Deep Learning	
CSCI 6502	Big Data Analytics: Systems, Algorithms, and Applications	

Human-Centered Computing (HCC) (https://www.colorado.edu/cs/human-centered-computing-sub-plan-requirements/)

Code	Title	Credit Hours
Core Courses		
Choose five:		
CSCI 5229	Computer Graphics	
CSCI 5239	Advanced Computer Graphics	
CSCI 5402	Research Methods in Human-Robot Interaction	
CSCI 5616	Introduction to Virtual Reality	
CSCI 5809	Computer Animation	
INFO 5501	Open Collaboration	
INFO 5601	Ethical and Policy Dimensions of Information and Technology	
INFO 5602	Information Visualization	
INFO 5603	Survey Research Design	
INFO 5611	Ubiquitous Computing Experience Design	
CSCI 5839	User-Centered Design and Development 1	
CSCI 5849	Input, Interaction, and Accessibility	

CSCI 5919	HCC Survey and Synthesis: Foundations and Trajectories
CSCI 5929	HCC Survey and Synthesis: New Disciplinary Directions
CSCI 6402	Issues and Methods in Cognitive Science
CSCI 7772	Topics in Cognitive Science

Intelligent Systems (IST) (https://www.colorado.edu/cs/current-students/graduate-students/ms-degree/professional-ms-degree-requirements/intelligent-systems/)

Code	Title	Credit Hours
Core Courses		
Choose four:		12
CSCI 5254	Convex Optimization and Its Applications	
CSCI 5302	Advanced Robotics	
CSCI 5352	Network Analysis and Modeling	
ECEN 5322	Data and Network Science	
APPM 8500	Statistics, Optimization and Machine Learning Seminar	
CSCI 5502	Data Mining	
CSCI 5622	Machine Learning	
CSCI 5673	Distributed Systems	
CSCI 5722	Computer Vision	
CSCI 5822	Probabilistic Models of Human and Machine Learning	
CSCI 5832	Natural Language Processing	
CSCI 5922	Neural Networks and Deep Learning	

Numerical Computation (NUM) (https://www.colorado.edu/cs/current-students/graduate-students/ms-degree/professional-ms-degree-requirements/numerical/)

Code	Title	Credit Hours
Core Courses		
Choose four:		
CSCI 5229	Computer Graphics	
CSCI 5239	Advanced Computer Graphics	
CSCI 5446	Chaotic Dynamics	
CSCI 5576	High-Performance Scientific Computing	
CSCI 5676	Numerical Optimization	
CSCI 5606	Principles of Numerical Computation	
CSCI 5636	Numerical Solution of Partial Differential Equations	
CSCI 5646	Numerical Linear Algebra	

Robotics (RBT) (https://www.colorado.edu/cs/current-students/graduate-students/ms-degree/professional-ms-degree-requirements/robotics-sub-plan/)

Code	Title	Credit Hours
Core Courses		
Choose four:		
CSCI 5254	Convex Optimization and Its Applications	
CSCI 5302	Advanced Robotics	
CSCI 5622	Machine Learning	
CSCI 5722	Computer Vision	
CSCI 5922	Neural Networks and Deep Learning	
ASEN 5347	Math Methods in Dynamics	
ASEN 6020	Optimal Trajectories	
ASEN 6412	Uncertainty Quantification	
ECEN 5358	Optimization and Optimal Control	

Software Systems and Cloud Computing (SSC) (https://www.colorado.edu/cs/current-students/graduate-students/ms-degree/professional-ms-degree-requirements/software-systems/)

Code	Title	Credit Hours
Core Courses		
Choose four:		
CSCI 5135	Computer-Aided Verification	
CSCI 5253	Datacenter Scale Computing - Methods, Systems and Techniques	
CSCI 5273	Network Systems	
CSCI 5448	Object-Oriented Analysis and Design	
CSCI 5502	Data Mining	
CSCI 5525	Compiler Construction	
CSCI 5535	Fundamental Concepts of Programming Languages	
CSCI 5573	Advanced Operating Systems	
CSCI 5673	Distributed Systems	
CSCI 5753	Computer Performance Modeling	
CSCI 5817	Database Systems	
CSCI 5828	Foundations of Software Engineering	

Security (SEC)

Code	Title	Credit Hours
Core Courses		
Choose four:		
CSCI 5403/ CYBR 5300	Cybersecurity	
CSCI 5413	Computer Security and Ethical Hacking	
CSCI 5113		
ECEN 5113		
ECEN 5793	Secure Computer Architecture	
CYBR 5350	Security Auditing and Penetration Testing	
CYBR 5320	Cybersecurity Network Analytics	
CYBR 5330	Digital Forensics	
CYBR 5830	Special Topics (Embedded Cybersecurity; Software Reverse Engineering)	

Dual Degree

MSCPS/EMEN in Computer Science and Engineering Management

Computer Science and Engineering Management (https://www.colorado.edu/emp/) have teamed up to offer an exciting dual degree (https://www.colorado.edu/cs/current-students/graduate-students/ms-degree/dual-professional-ms-engineering-management/) for MSCPS students. Student complete a total of 45 credits of graduate-level

coursework. Of those, 24 credits are in CS courses and 21 credits are in EMEN courses. All degree requirements must be completed within four years of the date of commencing coursework.