**MASTER'S** DEGREE PROGRAM IN

# Computer Science

**College of Engineering**
**University of Colorado Denver**

*These degree requirements are in effect starting from 2018-2019 Admission.*

The Department of Computer Science and Engineering offers a Master of Science degree in Computer Science.

**Research areas of emphasis include:** algorithms, automata theory, artificial intelligence, big data management and mining, bio-informatics, cloud computing, communication networks, combinatorial geometry, computational geometry, computer graphics, computer security, computer systems, cyber physical systems, cyber security, database, distributed computing, graph theory, high performance computing, information theory, internet, mobile computing, mobile health systems, machine learning, parallel processing, simulation, and software engineering.

## Admission Requirements

Applicants should hold a bachelor's degree from an institution comparable to the University of Colorado. They need to have sufficient programming experience and mathematical maturity and computer science background to understand advanced courses.

Qualified applicants holding a degree outside Computer Science or equivalent fields may need to take some foundational computer science courses before starting the graduate program.

Admission decisions are based on prior academic performance, letters of recommendation, English proficiency if applicable, GRE scores if applicable, as well as the applicant's written statement of purpose.

Additional requirements include:

1. University- level Calculus I and Calculus II (equivalent to two semesters); and
2. at least one math course beyond Calculus, such as Advanced Calculus, Differential Equations, Linear Algebra, Probability, Statistics, or Combinatorial Analysis.

Admissions tracks:

1. Student has satisfied the CS foundational courses during their undergraduate in Computer Science: the MS-CS program will be a minimum of 30-credit hours satisfying the program requirements

2. Applications from majors that satisfy the admissions criteria but are lacking some CS foundational courses: A specific plan of study is devised in your admission plan specifying the number of CS foundational courses to be completed during the first year of your studies with a minimum grade of B. In addition to these courses, you will need to complete a minimum of 30-credit hours satisfying the program requirements.

### Grade Point Average (GPA):

Applicants are expected to have grade point average (GPA) of at least 3.0.

### GRE Scores (*effective for fall 2015 admission*)

Applicants must submit evidence of adequate preparation for graduate study by either (a) submitting official GRE scores, or (b) documenting an earned bachelor's degree with a GPA of 3.00 or higher from an institution accredited by a U.S. accreditation body, or an earned master's degree with a GPA of 3.5 or higher from an institution accredited by a U.S. accreditation body. Use Institution Code 4875, Department Code 1102. Strong candidates typically have verbal plus quantitative scores exceeding 310.

### International Students:

Applicants whose native language is not English must take either the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) exam and must score above 537 (paper) or 75 (internet based) or 6.5 on the IELTS. Applicants whose native language is not English are not required to take the TOEFL test if they have completed a baccalaureate or graduate-level degree program at an English-speaking college or university or have completed at least 2 semesters at a college or university in the United States as a full-time student and obtained a "B" average (3.0 GPA) or higher.

### Admission Decision:

Candidates applying for the MS study will be individually evaluated by the Department's Graduate Committee. A letter with a decision will be sent to the applicant by the Graduate Committee Chair.

## MS in Computer Science Degree Requirements

Upon offer of admission into the MS program, students are required to show adequate preparation for their degree plan. Depending on education background, students may be required to complete up to 12 credit hours of core foundational courses in addition to the required **30** graduate credit hours. (Qualified applicants with no CS background who are interested in graduate studies in CS may need more foundational courses.)

Master's degree candidates are required to complete a program of study consisting of at least

30 semester hours of graduate level computer science courses while maintaining a grade point average of at least 3.0 overall. According to the Graduate school rules, graduate courses with grades below B- cannot be applied towards the completion of the graduate degree.

Students need to submit an approved Plan of Study to the Department during the first semester of their admission. Students must consult their assigned advisor to develop a Plan of Study.

Students may choose **Plan I** (thesis), **Plan II** (project), or **Plan III** (course only). Both Plan I and II require successful defense of thesis or project in student's graduating semester. Plan III requires successful completion of a final MS course project during student's graduating semester.

### Plan I – Thesis:

Students take 24 hours of graduate course work, and additionally write and defend a thesis, which counts for 6 hours of graduate thesis work. In this plan students will take three out of four "category A" courses, a minimum of four "category B" courses, and six hours of MS thesis. In addition, students may take an "Independent Study" course or one "category C" course with approval of their faculty research advisor. Note: a fourth category "A" course can be counted toward satisfying category "B" requirement as well.

### Plan II – MS Project:

Students take 27 hours of graduate course work, and additionally write and defend a MS project report, which counts for 3 hours of graduate MS project work. In this plan students will take four "category A" courses, a minimum of four "category B" courses, and three hours of MS project. In addition, students may take an "Independent Study" course or one "category C" course with approval of their faculty research advisor.

### Plan III – Course Only:

Students must take 30 hours of graduate course work. In this plan students will take four "category A" courses and a minimum of four "category B" courses, and a maximum of two "category C" courses. All four category "A" courses must be taken, however, MS course only option students may take an additional category "B" course to make up a lower than passing grade in a category "A" course.

One of the category "B" courses must be from a designated list of courses that will satisfy a final MS course project. Students may take these designated courses to satisfy category "B" requirements without the designation of final MS course project. However students in course-only option, will select one such course based on their interest from the approved list of courses to conduct a more in-depth project:

**Final Project MS course:**

- List of approved final project MS courses will be available in the CSE department.

- The final MS course project may be taken after completing at least three (3) "category A" courses.
- Students will notify the department [chair of the Graduate Committee] of their course selection by the second ($2^{nd}$) week of the semester.
- The instructor of final MS project course submits his/her evaluation along with the completed course project report to the Graduate Committee by the end of each semester.
- Final course project must meet the following requirements:
  1. Must be an individual semester term project.
  2. Must demonstrate the mastery of the subject.
  3. Must demonstrate scholarly/scientific knowledge acquired over the course of their MS studies.
  4. Must require significant research and implementation.
  5. Must produce a written a final report documenting research, implementation, results, analysis, and bibliography.

***Academic Advisor***

- A student, who is in **Plan I** (thesis), and **Plan II** (MS project), will need to choose a CSE full-time faculty member with a graduate faculty appointment as a Thesis/MS Project Advisor. The Thesis/MS Project Advisor will chair the Thesis/MS Project Committee. The Thesis/MS Project Committee will consist of at least three members, two of whom must be CSE graduate faculty members.

- Thesis/MS Project and Independent Study supervision:

  1. Full-time faculty CSE faculty who are members of UCD Graduate School may supervise thesis, MS Project, and graduate independent studies.

  2. Tenured/tenure-track faculty from outside of CSE department may co-advise MS thesis, MS Project, and graduate independent studies, along with the approval of the designated CSE faculty advisor.

  3. Part-time CSE faculty, e.g., lecturers, honoraria, graduate students, may not supervise thesis and MS Project. They may, however, serve as informal supervisors of graduate independent studies, sponsored by a full-time tenured/tenure-track CSE faculty who is a member of the UCD Graduate School faculty as the supervisor-of-record.

- Students in the thesis plan have priority in obtaining departmental assistantships.

## CSE Graduate Course Areas in Computer Science

MS students will take graduate CS courses in the following categories:

### 1 - Category A ("core")

Every MS Project and course option students will need to complete the following four courses to satisfy the core requirement:

CSCI 5446 Theory of Automata
CSCI 5451 Algorithms
CSCI 5593 Advanced Computer Architectures
CSCI 5573 Operating Systems

### 2 - Category B ("breadth")

In addition to the core courses (Category A), students will breadth take courses from courses taught by the full-time graduate faculty in the CSE Department. The graduate CS course list to satisfy breadth course requirement is maintained on the department website for each semester. The availability of the courses may vary from semester to semester. Students must confirm if a certain course is offered in a specific semester through the department's website. Students must consult their faculty advisor for their course selection and degree planning.

### 3 - Category C

- Depending on the plan you choose, up to 3 courses can be taken from Category C courses described below.
- A student in **Plan I** (thesis) or **Plan II** (project) must select either CSCI 6950 MS thesis (6 credit hours maximum) or CSCI 6960 MS project (3 credit hours maximum).
- A student in **Plan III** (course only) must declare their MS course project to the CSE Department within the first two weeks of their final semester.
- Graduate Independent study is optional and allows up to 3 credit hours maximum. It is only applicable to students in **Plan I** (thesis), and **Plan II** (project) options. **Plan III** (course only) students are not eligible to count CSCI 5840 Independent study toward degree requirements.
- Students may take appropriate graduate courses from Mathematics and other Engineering departments with a prior approval of graduate committee (category C).

### Transfer of Credit:

A maximum of nine semester hours of graduate course work may be transferred into the program based on department approval. In principle, core courses must be taken from the CSE department at CU Denver.

## Data Science in Biomedicine Track

**Master of Science, Plan I**

The Data Science in Biomedicine Track is offered under the Computer Science Master of Science degree program for students who choose Plan I - Thesis. It is best to plan out the track starting the first year to ensure timely graduation and availability of electives.

**Track Requirements**

- 36 credits total
- Take 9 credits of electives from a list of courses related to Biomedical Computing and Informatics, Bioinformatics, Health Informatics, etc. (meet with an advisor for current course offerings).
- Satisfy CS-MS Plan I program core requirements.
- Select electives among CS courses focused on data science and engineering, to specialize your MS studies on data science as compared to the original MS degree.
- Write a thesis with a focus on Data Science in Biomedicine.

# Certificates of Completion

## Graduate Certificate in Software Engineering

### Certificate Objectives

To provide working or career-oriented students with knowledge and practice of the applied skills needed to become successful software engineers.

***Process to Attain Certificate Objectives***

Students are required to take the following courses:

- Software Architecture (CSCI 5010) AND
- Software Project Management (CSCI 5011) AND
- Either CSCI 5573 (Operating Systems) or CSCI 5593 (Advanced Computer Architectures

Students must take and pass each course with a grade of B- or better and earn a GPA of at least 3.0 to obtain the Software Engineering Certificate.

## Graduate Certificate in Cyber Security and Defense

### Certificate Objectives

With the advent of greater network, application, and infrastructure connectivity there are more advanced methods of cyber-attack. This certificate program focuses on both the technical and analytical aspects of advanced cyber security and defense. Graduates of this certificate program will learn how to mitigate known cyber-related attacks against multiple network and infrastructure devices. Graduates will also learn how to design secure solutions, analyze new cyber-attacks and provide solutions that balance risk, security, privacy, cost, and operations. Each course in this certificate program provides project-based opportunities to

extend technical skills in programming, network, operating system, infrastructure design and analysis as well as understanding prevention of cybersecurity breaches and incidents.

***Process to Attain Certificate Objectives***
Student will need to complete a sequence of four separate graduate-level courses

- CSCI 5742 —3 credits - Cybersecurity Programming and Analysis
- CSCI 5743 —3 credits – Cyber and Infrastructure Defense
- Two of the following dependent on student background. (Students must meet with a CSE faculty advisor to determine which courses.)
    - CSCI 5573 —3 credits – Operating Systems
    - CSCI 5765 - 3 credits – Computer Networks
    - CSCI 5799 – 3 credits – Cloud Computing

Students must take and pass each course with a grade of B- or better and earn a GPA of at least 3.0 to obtain the Cyber Security and Defense Certificate.

## Students' Responsibilities and Steps to Follow

Failure to follow these steps may prolong or stop your graduation. All students are responsible to adhere to the Academic Calendar, and Graduate School dates and deadlines published every semester.

1. All new students must attend an orientation that is held the Thursday of the week before the start of every semester

2. New students must prepare a plan of study and receive approval from an advisor, within the first month of their first semester. Forms will be available on the CSE web-site.
3. Students must receive a graduate advisor's approval for any change to their initial plan of study.
4. **Graduation check** (required for all students intending to graduate):
    **a.** A student in **Plan III** (course only) must enroll in the CSE Department for their selected final project MS course within the first two weeks.
    **b.** Students must apply for graduation through the UCDAccess student portal between the first day of registration for the term and census date for the term they are intending to graduate.
    **c.** Students may apply for admission to candidacy by completing the required forms. The form is on-line located on the Computer Science web-site. The form must be completed at the beginning of the semester the student intends to graduate (deadlines are published by the Graduate School every semester). Students must make an appointment and meet with a graduate advisor to have their application for candidacy approved.
    **d.** Students in MS thesis option, must follow Graduate School guidelines for thesis preparation, submission, and deadlines.

## Adequate Progress toward MS in Computer Science Degree

- Students are expected to finish the MS degree program within 5 years. Candidates for the MS degree may not get credit for a course taken longer than five years before the date on which the degree is to be granted.

- Students who do not enroll for any course work in the graduate program in a Fall or Spring semester need to notify the Computer Science and Engineering Department in writing. Students who are not enrolled for three consecutive Fall or Spring semesters might be removed from the program.

## Contact Information:

Please contact the CSE Department for information, appointments, and inquiries:


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