ROBOTICS - MASTER OF SCIENCE (MS)

The Master of Science in Robotics provides advanced training and study in robotics-related topics consistent with the program focus on autonomy and AI, field robotics, human-robot interaction, smart materials, security, controls and estimation, bio-inspired systems and advanced manufacturing.

The program provides a strong foundation in mathematics and engineering, while also allowing flexibility to select courses across departments to achieve the breadth and depth required for research advances beyond the state of the art. Students will achieve their educational goals through a combination of cross-disciplinary coursework and research under the supervision of one or more of the program's faculty members.

For more information, see the Robotics (https://www.colorado.edu/program/robotics/academics/) website.

Required Courses and Credits

The non-thesis and thesis MS options both require a minimum of 30 credit hours of coursework in courses numbered 5000 or above, with a minimum GPA of 3.00. MS thesis option students must complete 4–6 hours of thesis credit as part of the 30 credit hour requirement and meet thesis examination and submission requirements. Non-thesis option students are not required to complete a final examination. All courses listed on the Application for Admission to Candidacy must have been taught by members of the graduate faculty, must have grades of C or better, and must be at the 5000 level or above. For policies concerning academic probation, refer to the graduate school rules in the University Catalog. A maximum of 9 credit hours of graduate coursework may be transferred from another accredited institution, assuming the courses meet program and Graduate School standards.

The MS degree in Robotics will provide a flexible curriculum that provides depth of study across the disciplines from departments and programs hosted in CEAS, including Architectural Engineering (AREN), Aerospace Engineering (ASEN), Biomedical Engineering (BMEN), Chemical Engineering (CHEN), Civil Engineering (CVEN), Computer Science (CSCI), Electrical, Computing and Energy Engineering (ECEN), Electrical Engineering (EEEN), Engineering Management (EMEN), Environmental Engineering (EVEN), Mechanical Engineering (MCEN) or ATLAS. Of the 30 credit hours of coursework required, at least 18 credit hours will be specifically in designated robotics (ROBO) courses, with the remaining credit hours obtained, as needed, from other departments listed above. Of the 18 credit hours of robotics coursework required, one core course is required: ROBO 5000 Introduction to Robotics, which provides a foundation for advanced study. This allows for maximum flexibility for students to tailor coursework for a variety of post-graduate career goals. Additionally, the Robotics Graduate Program will provide guidance on recommended courses in the basic concentration areas, but each student is required to develop a course plan and submit to the graduate committee for approval.

Thesis Examination

A minimum of 4 and maximum of 6 thesis credit hours are required for the thesis option of the MS degree. Students must also write a thesis based on original research conducted under the supervision of a graduate faculty member. The MS thesis must fulfill all Graduate School requirements. After the thesis is completed, a final oral examination is conducted by the student's thesis committee of at least three faculty members. The approved thesis must be submitted to the program and the Graduate School.

Time Limit

All requirements for the MS degree must be completed within four years of admission to the MS program. Courses may be selected to maximize the number of credits obtained by a student in a given semester (e.g., for an accelerated MS degree), or spread out over multiple years (e.g., for working professionals). A waiver from the Graduate Committee is required for every semester beyond the time limit listed above.

Course Requirements

A minimum of 18 credit hours is required (3 core plus 15 robotics electives).

Code	Title	Credit Hours
Core Course Requirement		
ROBO 5000	Introduction to Robotics	3
Robotics Electives		**15**
Robotics Courses in Computer Science		
CSCI 5254	Convex Optimization and Its Applications	3
CSCI 5302	Advanced Robotics	3
CSCI 5322	Algorithmic Human-Robot Interaction	3
CSCI/ATLS 5616	Introduction to Virtual Reality	3
CSCI 5622	Machine Learning	3
CSCI 5922	Neural Networks and Deep Learning	3
Robotics Courses in Aerospace Engineering Sciences		
ASEN 5014	Linear Control Systems	3
ASEN 5044	Statistical Estimation for Dynamical Systems	3
ASEN 5067	Microavionics: Introduction to PIC Microcontrollers for Aerospace Systems	3
ASEN 5254	Algorithmic Motion Planning	3
ASEN 5264	Decision Making under Uncertainty	3
ASEN 6024	Nonlinear Control Systems	3
ASEN 6044	Advanced State Estimation	3
ASEN 6519	Special Topics (Hybrid Systems)	3
Robotics Courses in Mechanical Engineering		
MCEN 5115	Mechatronics and Robotics I	3
MCEN/ECEN 5138	Feedback Control	3
MCEN 5155	Automated Mechanical Design Synthesis	3
MCEN 5157	Modeling of Human Movement	3
MCEN 5173	Finite Element Analysis	3
MCEN 5195	Bioinspired Robotics	3
MCEN 5228	Special Topics in Mechanical Engineering (Advanced Dynamics)	3
MCEN 5228	Special Topics in Mechanical Engineering (Industrial Automation)	3
MCEN 5293	Mechanics of Soft Matter	3
MCEN/ECEN 5448	Linear Systems	3
MCEN 5636	Micro-Electro-Mechanical Systems 1	3

MCEN 6228	Special Topics in Mechanical Engineering (Robust Multivariable Control)	3
Robotics Courses in Electrical Engineering		
ECEN 5008	Special Topics (Game Theory)	3
ECEN/MCEN 5138	Control Systems Analysis	3
ECEN/MCEN 5448	Advanced Linear Systems	3
ECEN 5458	Sampled Data and Digital Control Systems	3
ECEN 5478	Online Convex Optimization and Learning	3
ECEN 5638	Control Systems Laboratory	3
ECEN 5738	Theory of Nonlinear Systems	3
Robotics Courses in Atlas		
ATLS/CSCI 5616	Introduction to Virtual Reality	3
Technical Electives		**12**
Courses in STEM fields will be considered, provided they are related to the research goals of the student.		

Learning Outcomes

Upon completing the program, students will:

- Possess a working knowledge of the tools specific to their research area. (Non-thesis and thesis)
- Communicate effectively (orally and written) about their research area to roboticists within and outside of their focus area. (Thesis only)