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 and industry advances beyond the state of the art. Students will achieve their educational goals through interdisciplinary coursework and optional research opportunities under the instruction of one or more of the program's faculty members.

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

Degree Requirements

The MS in Robotics offers a flexible curriculum that encourages in-depth study across disciplines from departments and programs hosted in the College of Engineering & Applied Science (CEAS), including aerospace engineering sciences, biomedical engineering, chemical and biological engineering, civil, environmental, and architectural engineering, computer science, electrical, computing, and energy engineering, engineering management, mechanical engineering, and the ATLAS Institute. To fulfill graduation requirements, students must complete a minimum of 30 credit hours of coursework in courses numbered 5000 or above and taught by members of the graduate faculty, with grades of C or better and a minimum GPA of 3.00. Students may choose to pursue one of two program options: thesis or non-thesis. More detailed information on course requirements and a list of approved courses can be found at the bottom of this page, under "Course Requirements."

Students in the MS thesis option must complete 4–6 hours of MS thesis credit, two hours of ROBO 5009 Robotics Seminar and one hour of ROBO 5008 Introduction to Research, as part of the required 30 credit hours. They must also meet thesis examination and submission requirements. Non-thesis MS students must complete all coursework requirements but are not required to complete a final examination. A maximum of nine credit hours of graduate coursework may be transferred from another accredited institution if the courses meet program and Graduate School standards. For policies regarding good academic standing, please see the Academic Standards and Advising section of the university's Graduate Catalog.

Thesis Examination (MS Thesis Option Only)

In addition to completing the required coursework, students pursuing the MS thesis option must 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, which is made up of at least three faculty members. The approved thesis must be submitted to the program and the Graduate School.

Time Limit

Per Graduate School policy, all requirements for the program must be completed within four years of admission to the degree program. A waiver from the Graduate Committee is required for every semester beyond the time limit listed above. Students who wish to extend their time limit (up to one year) will also need to submit a petition to the Graduate School.

Course Requirements

Students must complete ROBO 5000 Introduction to Robotics, plus one course selected from each breadth bin (as listed below), to complete their robotics fundamentals requirements. These courses provide a foundation for advanced study in the field. The remaining 18 credit hours may be chosen from any of the courses on the approved list. This allows for maximum flexibility for students to tailor coursework for a variety of post-graduation career goals. Students may opt to replace up to six of those 18 credit hours with any course offered through a CEAS department or program as non-ROBO engineering electives. Any other course substitutions will require a petition to the Graduate Committee.

Students are not required to submit a course plan to the Graduate Committee for approval, but they are encouraged to work with the Graduate Program Assistant to identify specific courses that will help them reach their objectives.

Code	Title	Credit Hours
Core Course Requirement		
ROBO 5000	Introduction to Robotics	3
Breadth Requirement: Dynamics and Mechatronics		
Choose One:		3
ASEN 5050	Space Flight Dynamics	
ASEN 5067	Microavionics: Introduction to PIC Microcontrollers for Aerospace Systems	
ECEN 5853	Embedding Sensors and Motors	
MCEN 5115	Mechatronics and Robotics I	
MCEN 5173	Finite Element Analysis	
MCEN 5195	Bioinspired Robotics	
MCEN 5228	Special Topics in Mechanical Engineering (Advanced Dynamics)	
ROBO 5302	Advanced Robotics	
Breadth Requirement: Perception and Control		
Choose One:		3
ASEN 5044	Statistical Estimation for Dynamical Systems	
ASEN 5014	Linear Control Systems	
ASEN 5114	Automatic Control Systems	
ASEN 6024	Nonlinear Control Systems	
CSCI 5722	Computer Vision	
ECEN 5138	Control Systems Analysis	
ECEN 5244	Applied Stochastic Signal Processing	
ECEN 5448	Linear Control Systems	
ECEN 5738	Nonlinear Control Systems	
MCEN 5228	Special Topics in Mechanical Engineering (Advanced Computer Vision)	
Breadth Requirement: Cognition and Interaction		
Choose One:		3

ASEN 5254	Algorithmic Motion Planning	
ASEN 5264	Decision Making under Uncertainty	
CSCI 5254	Convex Optimization and Its Applications	
CSCI 5302	Advanced Robotics	
CSCI 5322	Algorithmic Human-Robot Interaction	
CSCI 5622	Machine Learning	
CSCI 5832	Natural Language Processing	
CSCI 5854	Theoretical Foundations of Autonomous Systems	
CSCI 5922	Fundamentals of Neural Networks and Deep Learning	
CSCI 7000	Current Topics in Computer Science (Deep Reinforcement Learning and Robotics)	
ECEN 5478	Online Convex Optimization and Learning	
Seminar and Research Requirement (MS Thesis Only)		
ROBO 5008	Introduction to Research (Intro to Research) [1]	1
ROBO 5009	Robotics Seminar [1]	1
ROBO 6950	Master's Thesis [2]	1-6
Robotics Electives [3]		**18**
ASEN 5128	Small Uncrewed Aircraft System Guidance, Navigation, and Control	
ASEN 6010	Advanced Spacecraft Dynamics and Control	
ASEN 6044	Advanced State Estimation	
ASEN 6412	Uncertainty Quantification	
ASEN 6519	Special Topics (Hybrid Systems)	
ASEN 6519	Special Topics (Verifiable Control of Stochastic Systems)	
ASEN 6519	Special Topics (System Identification for Control)	
ASEN 6216	Human Operation of Aerospace Vehicles	
CHEN 5836	Nanomaterials	
CSCI 5616	Introduction to Virtual Reality	
CSCI 7000	Current Topics in Computer Science (Physical Human-Robot Interaction)	
ECEN 5623	Real-Time Embedded Systems	
ECEN 5863	Programmable Logic Embedded System Design	
ECEN 5008	Special Topics (Game Theory)	
ECEN 5028	Special Topics (Constrained Control)	
ECEN 5458	Sampled Data and Digital Control Systems	
ECEN 5638	Control Systems Laboratory	
ECEN 5678	Control of Multi-agent Systems	
ECEN 5763	Embedded Computer Vision	
ECEN 5712	Machine Learning for Engineers	
MCEN 5157	Modeling of Human Movement	
MCEN 5228	Special Topics in Mechanical Engineering (Automated Mechanical Design)	
MCEN 5293	Mechanics of Soft Matter	
MCEN 5636	Micro-Electro-Mechanical Systems 1	
MCEN 5228	Special Topics in Mechanical Engineering (Mechatronics 2)	
MCEN 5228	Special Topics in Mechanical Engineering (Industrial Automation)	
MCEN 6228	Special Topics in Mechanical Engineering (Robust Multivariable Control)	

1. Two credit hours of Robotics Seminar and one credit hour of Intro to Research is required for MS thesis students and will replace three hours of robotics electives.
2. Master's Thesis (4-6 credit hours) is required for MS thesis students and will replace 4-6 hours of robotics electives.
3. Students may substitute courses from other departments and programs in the College of Engineering & Applied Science for up to six hours of robotics electives. Contact the Robotics Program for details.

Learning Outcomes

By the completion of the program, students will be able to:

- Core Knowledge in Robotics: Demonstrate an understanding of foundational robotics principles.
- Broad Competency Across Robotics Domains: Demonstrate interdisciplinary knowledge in robotics, covering at least three core areas of study.
- Technical Application Skills: Demonstrate capability to apply robotics tools and techniques in coursework to solve practical problems.
- Clear Technical Communication (MS Thesis only): Demonstrate capability to communicate robotics concepts effectively through written and oral assignments.