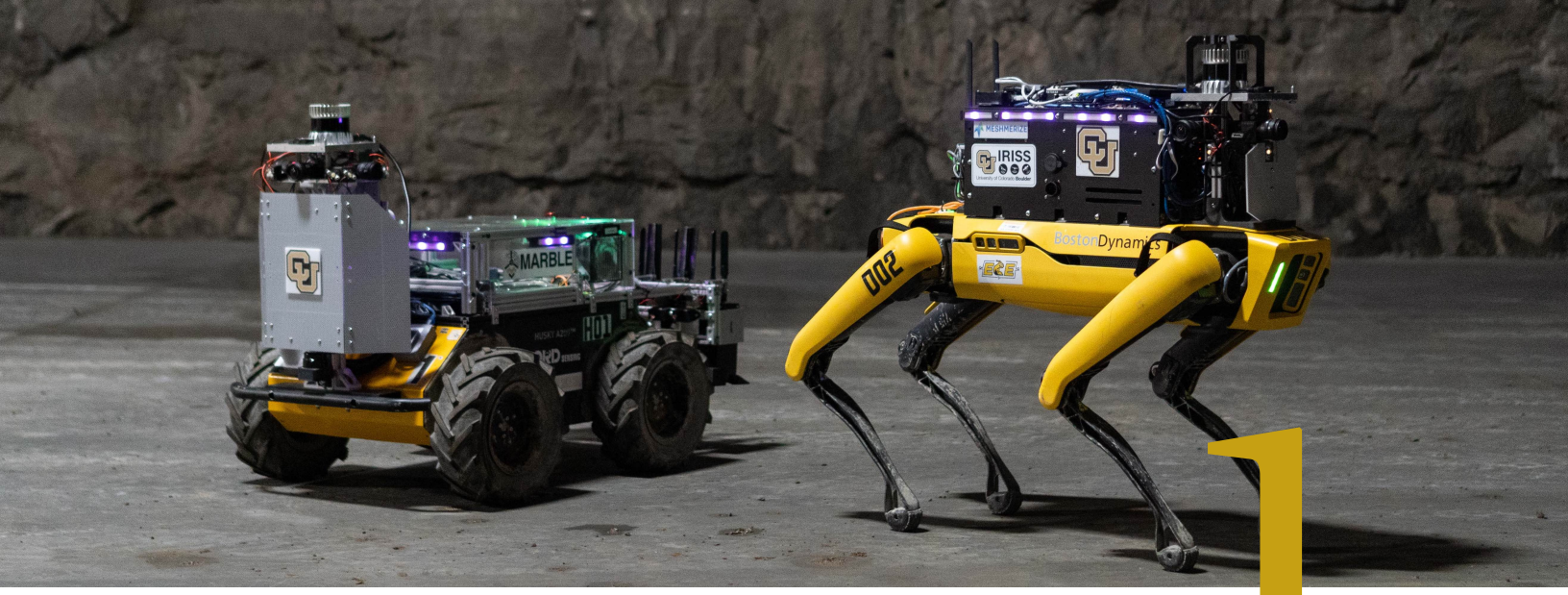
ROBOTICS GRADUATE PROGRAM HANDBOOK

UNIVERSITY OF COLORADO, BOULDER

2023-2024 ACADEMIC YEAR

LAST UPDATED: DECEMBER 17, 2024

Contents



1 Graduate Program Overview

1.1 Program Vision

The Robotics Graduate Program intends to shape the next generation of leaders in robotics with the aim of advancing basic and applied research in areas including autonomy and AI, field robotics, human-robot interaction, smart materials, security, controls and estimation, bio-inspired systems and advanced manufacturing.

- **Generate high-impact research:** Our faculty are internationally known for strengths in Reasoning, Decision Making and Assurance, Human-Centered Robotics, Smart Materials and Intelligent Mechanisms, Optimization and Control, Field, Service and Space Robotics, and Biomedical Robotics. Our faculty and students will continue to publish in high-impact journals, spin off technology companies, become future faculty, and serve on national advisory boards.
- **Be a leader in industry engagement:** As the specialty areas of robotics are constantly being re-shaped through innovative research, so are the skills and knowledge required by industry. Our MS programs are designed to provide the post-baccalaureate training (advanced) required for companies to successfully compete in today's ever-changing marketplace.

1.2 Degree Programs

With nearly 40 research and instructional faculty members, listed here, our graduate students have access to dynamic and interdisciplinary research and courses within our PhD and master's degree programs.

- **PhD Program:** Robotics PhD students at CU take part in cutting-edge, tier-one research, learning from nationally and internationally recognized faculty. Our research harnesses state-of-the-art experimental, theoretical, and computational approaches to expand the frontiers of technology, while advancing fundamentals in a wide range of disciplines.
- **Master's Degree Programs:** Robotics program master's degree students can take graduate courses and participate in research as part of two different programs.
  - *Master of Science (MS) Non-Thesis Program:* The MS Program is our most popular master's degree option, offering exciting opportunities for a wide range of prospective students from diverse backgrounds. It emphasizes project-based and curriculum-driven learning and is targeted at working engineers and undergraduates considering a career in industry.
  - *Master of Science (MS) Thesis Program:* The MS Thesis Program is intended for MS students interested in a short-term research experience, leading to the preparation and defense of a research-based thesis. The program emphasizes education through high-quality research for students interested in careers in industry and the public sector.

1.3 Contact Information and Personnel

The Robotics Program is located in the Engineering Center at CU, with the following physical and mailing addresses:

Physical address (map):	**Mailing address:**
1111 Engineering Drive	TBD UCB
Boulder, CO 80309	Boulder, CO 80309-TBD

Overall administration of the graduate program, review of applications, and admissions decisions are handled by the graduate committee. This committee consists of current members of our program faculty. Faculty on the graduate committee change from year to year and represent a range of different research and educational areas in our program.

During the 2023-2024 academic year, Prof. Sean Humbert will be the Director of the Robotics Program and Prof. Alessandro Roncone will serve as Associate Director and Graduate Program Chair. Anna Guy is the Senior Graduate Specialist responsible for PhD academic advising and admissions, Megan Varra is the Graduate Program Specialist who oversees MS academic advising and admissions, and TBD is the Graduate Program Specialist who oversees recruitment.

2023-24 Robotics Graduate Program Leadership, Advising, and Administration:

- **Dr. Sean Humbert**, Professor, Director
  sean.humbert@colorado.edu, ECES 156
- **Dr. Alessandro Roncone**, Assistant Professor, Associate Director and Graduate Program Chair
  alessandro.roncone@colorado.edu, ECES 124
- **Anna Guy**, Senior Graduate Specialist, PhD Students
  anna.guy@colorado.edu, ECME 105A
- **Megan Varra**, Graduate Program Specialist, MS Students
  megan.varra@colorado.edu, ECME 105
- **TBD**, Graduate Program Assistant (part-time), Prospective Students
  megrad@colorado.edu

If you have a question and are not sure who to contact, you can also email .

1.4 Student Expectations and Policies

A complete list of CU student, faculty, and staff policies, to which the Robotics Graduate Program rigorously adheres, can be found here. Graduate school policies are available here and a more comprehensive list of campus policies is available here. Select expectations and policies of greatest relevance to robotics program graduate students are provided in the following sections.

1.4.1 Honor Code Policy

All students of CU are responsible for knowing and adhering to the academic integrity policy. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; +1 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic and non-academic sanctions (including but not limited to university probation, suspension, or expulsion).

The University Honor Code and Procedures are accessible via the Student Conduct and Conflict Resolution website and can be viewed here. All Robotics Engineering graduate students are expected to adhere to this code.

1.4.2 Classroom Behavior Policy

Students and faculty each have a responsibility for maintaining an appropriate learning environment. Those

who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to instructors with the student's legal name, but instructors will honor student requests to address them by an alternate name or gender pronoun. Students should advise instructors of this preference early in the semester so that they may make appropriate changes to their records. Additional policy details are available here.

1.4.3 Discrimination and Harassment Policy

CU is committed to providing an inclusive environment where all individuals can achieve their academic and professional aspirations free from discrimination, harassment, and/or related retaliation based upon protected classes.

CU prohibits discrimination and harassment on the basis of protected-class status in admission and access to, and treatment and employment in, its educational programs and activities. For purposes of this CU policy, "protected classes" refers to race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, and political philosophy.

CU takes prompt and effective steps reasonably intended to stop any form of protected-class discrimination and harassment, and related violations, to eliminate any hostile environment, to prevent its recurrence, and as appropriate, to remedy its effects.

At CU, the Office of Institutional Equity and Compliance (OIEC) implements this policy and administers related campus procedures. Anyone who encounters an issue or seeks guidance related to this policy should consult with the OIEC. CU Boulder employees who are mandatory reporters (i.e., "Responsible Employees"), including faculty and graduate advisors, must promptly report allegations of protected-class discrimination and harassment, and related violations, as further outlined in the policy.

The full university Discrimination and Harassment Policy can be viewed here.

Instructors are required to observe religious holidays for absences from class and exams, according to the policies outlined here.

1.5 Mental Health and Other Campus Resources

Students with a variety of concerns, such as academics, anxiety, body image, depression, relationships, substance use and more, should contact Counseling & Psychiatric Services (CAPS), which is a confidential, on campus mental health and psychiatric service.

Counseling & Psychiatric Services (CAPS)
Website: https://www.colorado.edu/counseling/
Phone: 303-492-2277 (24/7 phone)
Location: Center for Community, N352
Office Hours

The Office of Victim Assistance (OVA) also provides free and confidential information, consultation, support, advocacy, and short-term counseling services to CU students, graduate students, faculty and staff who have experienced a traumatic, disturbing or life disruptive event.

Office of Victim Assistance (OVA)
Website: https://www.colorado.edu/ova/
Email: assist@colorado.edu
Phone: 303-492-8855 (24/7 phone); after hours press 2 to talk to a counselor
Location: Center for Community, N450
Office Hours

Additional campus resources can be found here and more general health resources are available here.

1.6 Grievance Procedures

The Graduate School established revised grievance procedures, effective April 1, 2019, that can be found here: Graduate School Grievance Procedures. These procedures are intended to provide a process by which graduate students can communicate concerns related to academic issues or academic conflicts. An additional brief guide is available here. Should a student need any assistance with these procedures, they should reach out to their Graduate and/or Faculty advisor, where appropriate.

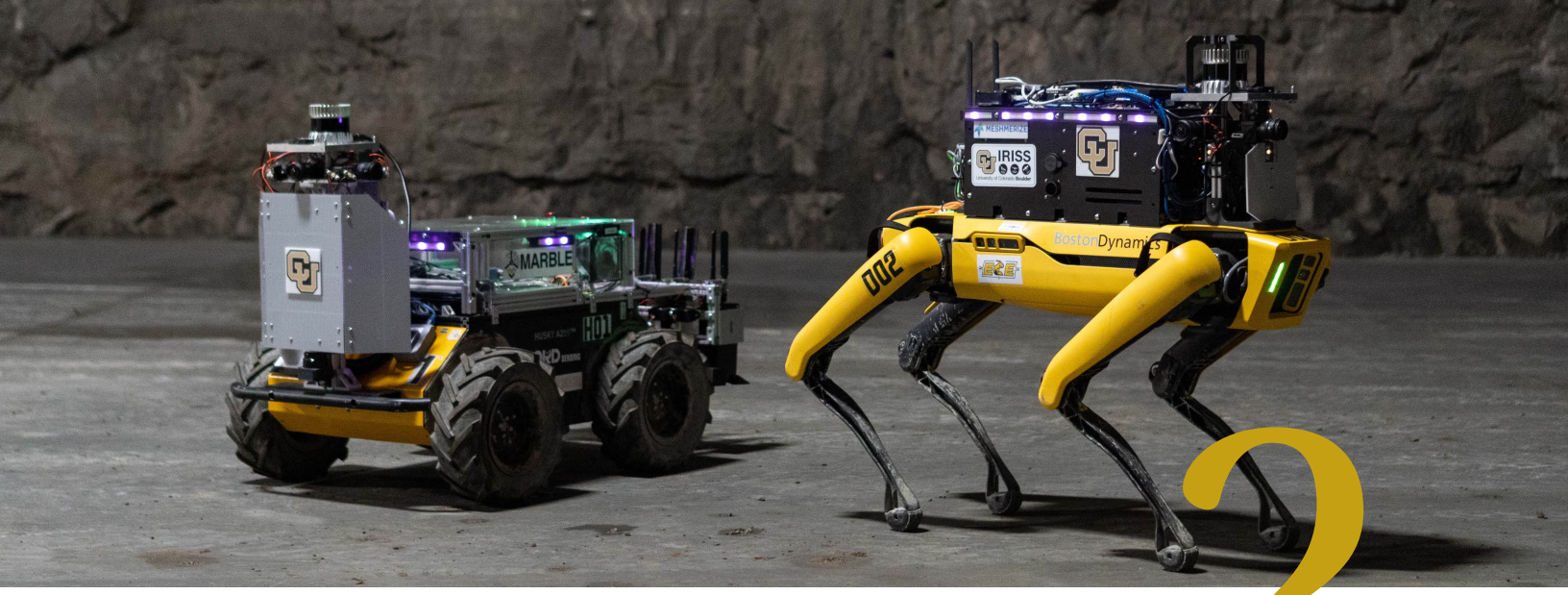
1.7 Academic Calendar and Registration Deadlines

Details on the current academic calendar can be found here. Additional information on course add/drop, tuition/fees, and registration deadlines is available from the Office of the Registrar. While the Graduate Program will make every effort to provide general reminders and information about important dates throughout the academic year, students are expected to be aware of any add/drop deadlines and tuition/fees impacts of their enrollment decisions. If you are unsure of the consequences of adding/dropping a course (especially outside of your university designated enrollment window), please reach out to .

1.8 Helpful Links

Additional resources and information of relevance to prospective and current robotics program graduate students can be found at:

- **University Home Page:** https://www.colorado.edu
- **Graduate School:** https://www.colorado.edu/graduateschool/
- **College of Engineering:** https://www.colorado.edu/engineering/
- **Robotics Graduate Program:** https://www.colorado.edu/program/robotics/
- **CU Class Search** https://classes.colorado.edu/
- **Buff OneCard:** https://www.colorado.edu/buffonecard/
- **Bursar's Office:** https://www.colorado.edu/bursar/
- **Campus Policies:** https://www.colorado.edu/policies/
- **Graduate School Catalog:** https://catalog.colorado.edu/graduate/
- **Medical Services:** https://www.colorado.edu/healthcenter/
- **Office of Information Technology:** https://oit.colorado.edu
- **Office of Institutional Equity and Compliance:** https://www.colorado.edu/oiec/
- **Office of the Registrar:** https://www.colorado.edu/registrar/
- **Parking and Transportation:** https://www.colorado.edu/pts/
- **Recreation Services:** https://www.colorado.edu/recreation/
- **Athletics:** https://cubuffs.com
- **Local News:** https://www.dailycamera.com
- **Elevations Credit Union:** https://www.elevationscu.com
- **Regional Transportation District (RTD):** https://www.rtd-denver.com



2 Admissions

2.1 Eligibility

2.1.1 PhD and Master's Degree Programs

To be eligible for either the PhD or master's (i.e., Non-Thesis MS or Thesis MS) degree programs, students must hold an undergraduate degree in engineering, sciences, or mathematics from an institution accredited by an agency recognized by the U.S. Department of Education. A complete list of accredited institutions and agencies is available from the Database of Accredited Post-Secondary Institutions and Programs.

Given the technical and quantitative nature of our graduate courses, any such degree should have included—or exceeded—the following course recommendations:

- Two semesters of calculus, differential equations with linear algebra OR a focused linear algebra course, and one semester of calculus-based physics;
- At least two semesters of upper-division undergraduate courses in engineering, computer science, or physical sciences;
- Completion of a third semester of calculus, a second semester of calculus-based physics, and/or a focused linear algebra course is preferred.

If an interested student has an undergraduate degree that does not cover these recommended courses, the graduate advising team should be consulted at robo@colorado.edu prior to applying. If a student has completed prior graduate coursework or a graduate degree that addresses some or all of the above course recommendations, they are fully eligible to apply for either the PhD or master's degree programs, even if the undergraduate degree does not satisfy the recommendations.

Scores from either the general or subject graduate record examination (GRE) are not required or accepted as part of applications to the robotics graduate program. Note also that students do not need a master's degree to be admitted to the PhD program. Many of our PhD students enroll directly from their undergraduate institution with only a bachelor's degree.

Although we recognize that the GPA alone does not paint a complete picture of an applicant's prior performance and future potential, our most competitive applicants meet the following targets:

- **GPA:** For PhD applicants, the preferred undergraduate and graduate GPA is 3.4 or above, and for master's applicants the preferred undergraduate and graduate GPA is 3.2 or above.

Prior to admission, applicants from countries where English is not the native language must demonstrate a full

command of the English language by taking the Test of English as Foreign Language (TOEFL). International applicants may also take the International English Language Testing System (IELTS), or the Duolingo English Test (DET). Preferred scores for each of these tests are the following:

- **TOEFL:** The minimum required score is 83, but a score of 90 or above is preferred, particularly for PhD applicants who potentially are seeking a Teaching Assistant (TA) position.
- **IELTS:** The minimum required score is 6.5, but a score of 7.5 or above is preferred.
- **Duolingo English Test (DET)**: The minimum required score is 120.

The TOEFL/IELTS/Duolingo requirement is waived for international applicants for whom English is their native language, or who have completed at least one year of full-time study at a U.S. institution (or at an institution in a country where English is the native language), within two years from the desired admission term. The list of countries exempt from the TOEFL/IELTS/Duolingo requirement can be found here.

2.2 Application Requirements

2.2.1 PhD and Master's Degree Programs

For students not currently enrolled as undergraduate or graduate students at CU who would like to be considered for the PhD or master's (i.e., Non-Thesis MS or Thesis MS) degree programs, the following items must be submitted (requirements and procedures are provided in Section 2.5 for internal applicants and current students seeking to change degree programs within the College of Engineering and Applied Science and/or CU):

- **Application:** An application must be completed through the official graduate school admissions website. Through this application, students can select the degree program to which they are applying (i.e., PhD or Non-Thesis MS), as well as the most relevant focus area (described in more detail for the PhD program in Chapter 3 and for master's degree programs in Chapter 4). Note that the MS Thesis program does not offer direct entry. Students interested in the MS Thesis program should apply to the MS Non-Thesis program. If admitted, students can formally switch to the thesis program upon securing a thesis advisor.
- **Application Fee:** An application fee of $60 for domestic and $80 for international applicants must be paid at the time of application. Additional information on application fee waivers is provided in Section 2.2.2.
- **Personal Statement:** A personal statement must be provided by each student that describes academic and research interests, prior research and professional experience, achievements, and/or additional information that the admissions committee should be aware of. Students applying for the PhD program, and those interested in the MS Thesis program, are encouraged to describe faculty and research groups with whom they are interested in pursuing research. The best personal statements tell a story and do not simply repeat information that can be found on the CV. Rather, the personal statement is where a student can outline their interests, future goals, and how their prior educational, research, and professional experiences have prepared and motivated them to pursue a graduate degree from CU.
- **Transcripts:** Unofficial transcripts must be provided from coursework at all post-secondary institutions (including community college courses, courses taken for college credit during high school, and study abroad coursework, even if this coursework shows as transfer credit on another transcript). Applicants offered admission who choose to matriculate at CU will be required to provide official transcripts for all schools attended prior to the beginning of their first semester.
- **Recommendation Letters:** Three letters of recommendation for PhD applicants and two letters of recommendation for MS applicants must be included in the application. Names and contact information for recommendation letter writers are solicited as part of the online application process. The strongest letters come from instructors/professors, research advisors, work supervisors, and others who can provide detailed comments on the potential of the student to succeed in graduate-level engineering coursework and, for PhD and MS Thesis interested students, research. Letters of recommendation from those outside of academia and/or research, as well as instructors of classes where a student received a poor grade or made little impression, are unlikely to help an application. Letters from family members will not be

considered.

- **TOEFL/IELTS/Duolingo Scores:** International students must submit unofficial TOEFL, Duolingo or IELTS scores using the institution code 4841 for CU. Once students are admitted, they must then submit official language scores in order to receive an I-20 for their visa application. This requirement is waived for international students who qualify under the following conditions: (a) the student's native language is English, or (b) the student has completed at least one year of full-time study at a U.S. institution (or at an institution in a country where English is the native language), at the time of submission, or within two years from the desired admission term. The list of countries exempt from the TOEFL/IELTS/Duolingo requirement can be found here.

To receive full consideration, all required application materials (including recommendation letters, unofficial transcripts, and unofficial TOEFL/IELTS/Duolingo scores) must be received by the deadlines outlined in Section 2.3.

GRE scores (either general or subject) are not required or accepted as part of a graduate application.

Note that all applicants for master's degrees must initially apply to the Non-Thesis MS degree program; direct entry to the MS Thesis program is not offered as it requires a commitment from a research advisor, which typically occurs after a student has enrolled at CU. Additional information on finding a research advisor for both PhD and MS Thesis applicants is provided in Section 2.6.

We recognize that financial support is an important consideration for prospective PhD and master's degree students, and additional detail on offers of admission and funding options in our department is provided in Section 2.4.

2.2.2 Application Fee Waivers

The Robotics Graduate Program recognizes that the application fee may be a challenge for some applicants. Our program is committed to providing educational opportunities for a diverse range of applicants and strives to waive application fees whenever possible. Please do not hesitate to contact us at robo@colorado.edu with any questions about the various fee waiver opportunities listed below.

1. Graduate School fee waivers are available for participants in the following programs. If you are affiliated with one of these programs, please email proof of your affiliation to gradadm@colorado.edu before you apply to receive a waiver.
   - AmeriCorps (currently serving)
   - Louis-Stokes Alliance for Minority Participation (LSAMP)
   - McNair Scholars Program
   - Minority Access to Research Careers (MARC) Scholars Program
   - Peace Corps (currently serving)
   - Post-baccalaureate Research Education Program (PREP)
   - Teach for America
   - Leadership Alliance
2. Members of the US military will receive an automatic application fee waiver from the graduate school upon submission of the application.
3. Domestic PhD candidates with a 3.4 or higher undergraduate GPA who apply for admission prior to November 15, 2023 will receive an automatic application fee waiver upon submission of the application.
4. Faculty members may request fee waivers for international PhD applicants by sending the name and application number of the international student to robo@colorado.edu.
5. Fee waivers are available to any CU Boulder undergraduate student applying to the PhD program.
6. Fee waivers may be requested for applicants eligible for accommodations via the Americans with Disabilities Act (ADA). Please note that students who chose not to utilize accommodations they were eligible for while an undergraduate are still eligible for a fee waiver.

To request a fee waiver from the department, please email robo@colorado.edu before you apply. Please include proof of affiliation or an explanation of your eligibility in your email.

2.3 Deadlines

2.3.1 PhD Degree Program

In general, our program accepts PhD applications from external (i.e., anyone not currently enrolled at CU) applicants for the fall term only. To receive full consideration, students should submit all application items noted in Section 2.2.1 by the following deadlines:

- **International and domestic applicants:** December 15, 2023

In limited cases, external PhD applications may be accepted and reviewed for the spring or summer semesters. Typically, these applicants are transfer students who have already identified a CU PhD advisor. In such instances, the graduate advising team should be consulted at robo@colorado.edu prior to applying. Applicants in this scenario should plan to ensure submission of all required application documents as soon as possible and no later than one month prior to the anticipated semester of matriculation.

Requirements and procedures for internal (i.e., current CU student) applicants to the PhD program are provided in Section 2.5.

2.3.2 Master's Degree Programs

In general, our department accepts MS applications from external (i.e., anyone not currently enrolled at CU) applicants for the Fall term only. To receive full consideration, students should submit all application items noted in Section 2.2.1 by the following deadlines:

- **International and domestic applicants:** December 15, 2023

To receive full consideration, all required application items (including recommendation letters and unofficial transcripts) must be submitted by the following deadlines for each term. International applicants must also submit unofficial language scores from TOEFL, IELTS, or Duolingo. Once an applicant is admitted to our graduate program, they must submit official language scores in order to be granted an I-20:

- **International and domestic applicants:** February 1, 2024 (for Fall 2024)

Requirements and procedures for internal (i.e., currently enrolled CU student) applicants to the master's degree programs are provided in Section 2.5.

Note that direct entry into the MS Thesis program is not permitted. Students interested in the MS Thesis program should apply to the Non-Thesis MS program. Upon procuring a thesis advisor, students admitted to the Non-Thesis MS program can formally switch into the MS Thesis program.

2.4 Offers of Admission and Funding

2.4.1 PhD Degree Program

Students applying to the PhD program will automatically be considered for funding as part of the admissions application process. The robotics program is committed to funding PhD students throughout the course of their studies. As such, students offered admission can expect a funding offer that includes a stipend, tuition coverage, dental coverage, and 90% of university health insurance coverage for the next academic year.

Funding offers take the form of mixed RA appointments. RA appointments, which typically span the duration of the first academic year (i.e., 9 months, from August 15 to May 15), are supported by individual faculty with funding from research grants or externally sponsored projects. Additional years as well as funding for the Summer semester (i.e., 3 months, from May 15 to August 15) may be provided depending on the sponsoring faculty member.

A number of incoming and current students also hold external fellowships, for example the National Science

Foundation (NSF) Graduate Research Fellowship. These students are considered "Fellowship" students.

In addition to appointments, PhD students may receive supplementary fellowships from the program or the College of Engineering and Applied Sciences as part of their funding offer. In most cases, these are one-time awards that can be used towards costs not covered by the RA appointment, such as student fees and room and board costs.

2.4.2 Master's Degree Programs

Generally, master's students are expected to self-fund their studies and, in nearly all cases, are admitted to the MS program with no offer of funding. Specifically, TA and RA funding from the program is reserved for PhD students, although a limited number of MS Thesis students may receive a TA or RA appointment through their research advisor. Such appointments are left to the discretion of the advisor and are not guaranteed even with acceptance or transfer into the MS Thesis program.

In accordance with Graduate School regulations, students in the Non-Thesis MS program are not eligible for RA or TA appointments. However, funding opportunities for Non-Thesis MS students do exist in the form of hourly employment.

2.4.3 Offer Acceptance Deadlines

The deadline for applicants to accept offers of admission and funding are:

- **MS and PhD Degree Programs:** April 15, 2024

Note that an offer of either admission or funding is only considered "accepted" if the enrollment deposit is paid, in full, by the above deadlines. If the deposit is not paid and no request for deferral has been made prior to the deadline, the offer will be considered as "declined" and will be rescinded by the department at its discretion.

2.4.4 Deferrals

Students who have accepted an offer of admission to either the PhD or Master's programs may request a deferral of their admission for up to one year. Both PhD and MS students may request to defer their admission to either the following fall or spring semester. Deferral requests will be considered on a case-by-case basis and should be communicated by email to robo@colorado.edu.

Note that students deferring an offer that includes financial support (e.g., a TA appointment) will be required to submit the admissions deposit in order to secure the offer for a future semester. Some sources of funding may not be deferred to future terms, including departmental scholarships. Applicants considering deferment should make sure to clarify the future availability of any funding offer.

2.5 Internal Applicants and Changes of Program

Current CU students, both inside and outside the program, can apply to either our master's or PhD degree programs by completing the Internal Graduate Program Application Form. After completing this form and satisfying the other requirements noted below, applications are reviewed in full by the graduate admissions committee. All candidates for admission, including internal applicants, are evaluated based on the same high standards of eligibility outlined in Section 2.2.

For all students transferring into the PhD program, the following items are required in order to submit the Internal Graduate Program Application Form:

- The name and contact information of a current member of the robotics faculty who can comment on the appropriateness of the change into the PhD program. In the case of students transferring into the PhD program without funding, this letter should come from a research advisor who commits to supporting the student for the duration of the PhD.
- A two-page statement from the student outlining research interests, prior research and professional experiences, and reasons for pursuing a PhD degree.

- Unofficial transcripts from CU and all prior undergraduate and/or graduate institutions.

2.5.1 Transfers within CU

All current CU undergraduate students outside the Robotics Program are required to submit applications according to the requirements outlined in Section 2.2 and the deadlines outlined in Section 2.3. Application fees are waived for these students.

For current graduate students in other departments at CU, transfers into either the master's or PhD degree programs can again be initiated by completing the Internal Graduate Program Application Form. Additionally, all such applicants are required to provide:

- The name and contact information of a current member of the CU faculty who can comment on the appropriateness of the change into the Robotics Program. In the case of students transferring into the PhD program without departmental funding, this letter should come from a research advisor who commits to supporting the student for the duration of the PhD.
- A two-page statement from the student outlining reasons for pursuing a degree in the Robotics Program, as well as research interests and prior research and professional experience if the student seeks to transfer into the MS Thesis or PhD programs.
- Unofficial transcripts from CU and all prior undergraduate and/or graduate institutions.

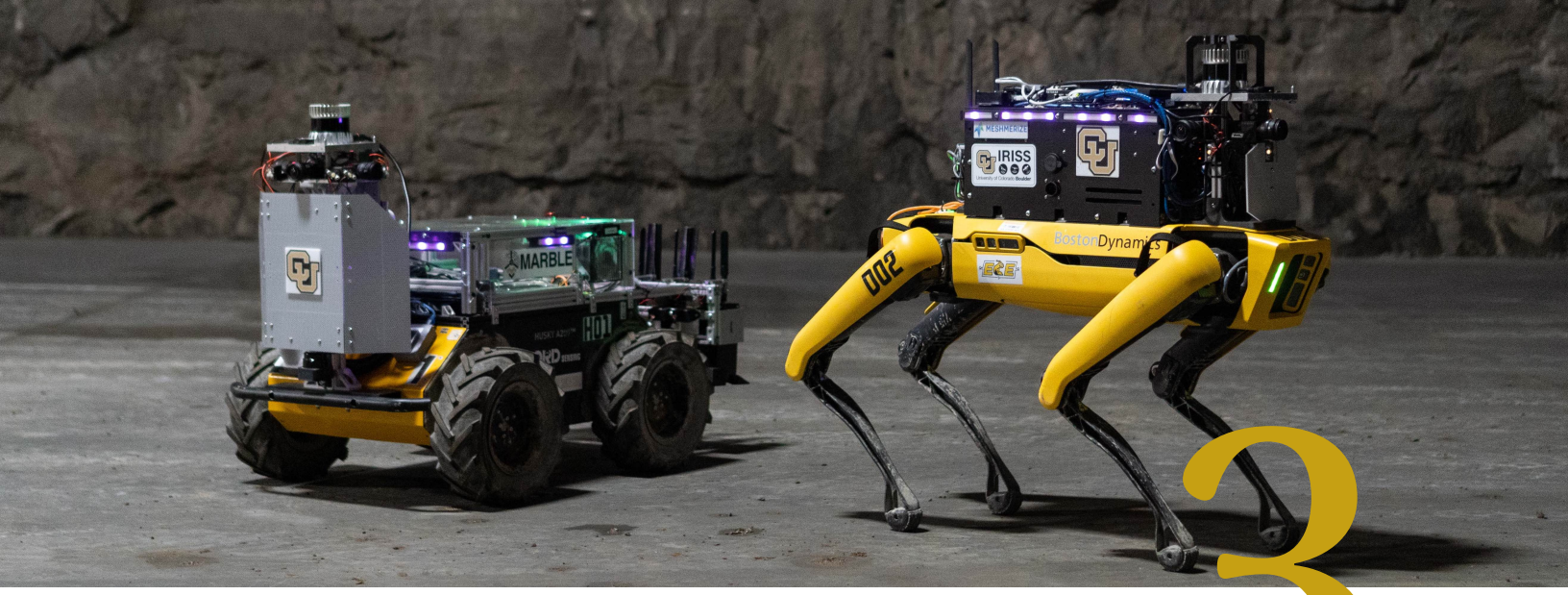
Students requesting transfer into either 1) the MS program; or 2) the PhD program, without request for department funding (i.e., those with an external fellowship or funding secured directly from the Research Advisor), are eligible to transfer at the beginning of any semester. The Internal Graduate Program Application Form should be submitted by December 1 for requests to begin during the spring semester, April 1 for requests to begin during the summer semester, and by August 1 for requests to begin during the fall semester.

PhD applicants seeking department funding are only eligible for transfer beginning in a fall semester. In these cases, the form must be submitted by January 15 to be considered for transfer beginning the following fall semester. Students will be considered, in conjunction with all external candidates applying to the PhD program, for a full academic year TA or RA appointment.

Note that these procedures and requirements apply even to students who are changing from another PhD program at CU into the Robotics PhD program.

2.6 Finding an Advisor

Admission to the PhD program is contingent on finding a faculty advisor. Students interested in the MS Thesis program can utilize the resources in this section, but should note that, in nearly all cases, a research advisor is not procured until after matriculation. You can read more about our faculty and their various research interests here.



3 PhD Degree Program

3.1 Overview

The PhD program in Robotics is available to students who are entering graduate studies for the first time (i.e., with only a BS or BA degree), as well as to those who already have a master's (MS) degree. While an MS degree is not required to enroll, PhD students without a prior MS degree are typically able to earn one on the way to their PhD degrees. Many incoming PhD students will have prior degrees in some type of engineering or computer science, although students from other fields, such as physics, mathematics, biology, and chemistry, are also routinely admitted and can acquire any missing background material during the course of their PhD studies at CU. Students graduating with a PhD from the Robotics Program are expected to have extensive fundamental and foundational knowledge in their field of study, in addition to being research experts.

3.2 Mission Statement

The primary objective of the PhD degree program is to educate students to the highest levels of their chosen field, in order to make lasting and significant impacts to fundamental knowledge, technology, and society through their research. PhD students are expected to become domain experts and to complete research that can withstand the rigorous test of external peer review. Graduates from the PhD program go on to careers in industry, academia, and the public sector, and are expected to become leaders in their respective fields. Each PhD graduate is a lifelong representative of CU and the Robotics Program and, as such, is expected to act professionally, ethically, and with integrity during their time at CU and beyond.

3.3 Timeline

A PhD student entering without prior graduate coursework will typically take five years to complete the PhD degree. However, it is not uncommon for students to finish both earlier and later than this five-year average. A student entering the PhD program with prior graduate coursework from another university may be eligible to transfer up to 21 credit hours to CU and can typically finish in 3-4 years. Regardless of the time taken to complete the PhD, the primary emphasis is on remaining at CU long enough to complete high quality research that satisfies the requirements of the PhD dissertation and defense. If a student is nearing the completion of their sixth year in the PhD program, they are required to file a time-limit extension via this online form. Please contact the graduate advisors at robo@colorado.edu for more information on requesting a time limit extension.

3.4 Requirements

Table 1 provides a description of each major requirement leading to completion of the PhD degree in robotics. A checklist of PhD graduation requirements is also available from the Graduate School here.

Requirement	Notes	Typical completion
	Pre-comprehensive exam student status	
Research group	Research expectations form	End of 1st semester
Robotics Intro	B- or higher in ROBO 5xxx: Introduction to Robotics	End of 1st semester
Oral preliminary exam	Research and subject exam	After 3 semesters
Course hours	30 hours, with 18 hours of ROBO classes	End of year 2
Comprehensive exam	Oral presentation and report	During year 4
	Post-comprehensive exam student status	
Dissertation hours	30 hours	End of year 5
Written dissertation	Completed 2 weeks before defense	End of year 5
Dissertation defense	Oral presentation	End of year 5

Table 1: Requirements leading to the PhD degree, including typical completion dates and updates to student status. Dates listed are typical for completion.

3.4.1 Course Requirement

PhD students in the Robotics program must complete a minimum of 30 graduate-level credits at the 5000 level or higher. All PhD students are required to fulfill the requirements of the MS program as listed in Section 4.4.1.

Some research advisors will require that their students complete more than 30 course credits. The graduate program recommends that, in addition to their graduate advisor, students consult their research advisor regarding any coursework recommendations or requirements.

In order to receive credit towards the PhD, students must receive a grade of at least B- in each course taken. Courses in which a grade below B- is achieved cannot be counted towards the PhD course requirement. Courses taken on a P/F basis cannot count towards the PhD course requirement.

Students must have a cumulative 3.0 GPA in order to be eligible for graduation. However, a 3.25 GPA is required for students to be eligible for Teaching or Research Assistantships.

3.4.2 Transfer Credit

Although students do not need an MS degree to be admitted to the PhD program, students who already have an MS degree, or have completed eligible graduate level coursework, may transfer up to 21 hours of credits towards the PhD course requirements. More information is available on the second page of the Request for Transfer of Credit Form from the CU Graduate School. To transfer credits, students must fill out and submit this form to their graduate advisor at with an official transcript(s) included.

Note that requests for transfer credit can only be made after completing 6 credits of graduate level coursework at CU. These requests should be submitted as soon after completion of this 6 credit requirement as possible. Typically, this means that transfers of credit are processed during the second semester of PhD study at CU.

3.4.3 Oral Preliminary Exam

All PhD students must pass the oral preliminary exam, the goal of which is to assess fundamental and practical preparation for a research-intensive program. As such, the exam combines a “research” component with a “fundamentals” component to provide a holistic picture of a student’s preparation. The research component consists of a short presentation by the student focused on a research topic that they could initiate, followed by questions from the exam committee. This part of the exam requires students to demonstrate their ability to synthesize primary sources, identify and communicate technical gaps in the relevant literature, and articulate a sound research plan. The fundamentals component consists of up to four questions pertaining to two breadth courses from two different breadth bins of the student’s choice. This part assesses a student’s knowledge consolidation, internalization, and retention in relation to core course material, which should provide a foundation for their future learning and research. Students may choose to be tested over any breadth course in a given bin. However, specific courses are recommended as preparation for the preliminary exam. Students should consult

with their faculty advisor for additional guidance on course selection to prepare for the preliminary exam. For each breadth course selected by the student, the committee will be provided with a question bank of 4-10 questions that are prepared by the course instructor and shared ahead of time with the student. If a question bank is not available for a specific course, the student's faculty advisor will reach out to the Graduate Committee and request preparation of a question bank for that course. In these cases, the Graduate Committee must receive sufficient advance notice in order for this request to be fulfilled. Both components of the exam allow the exam committee to assess a student's on-the-spot technical communication skills early in their career.

Oral preliminary exams for PhD students should be completed sometime during their third semester in the robotics PhD program. Based on student performance, the preliminary exam committee will provide an evaluation of pass, conditional pass, or fail. If the result is a conditional pass, the committee may require (in consultation with the student's advisor) the student to retake a portion of the exam or to complete another condition that displays fundamental proficiency. If a student fails a preliminary exam, they will either be asked to retake the exam in full at the next opportunity, or may be asked to leave the PhD program. Students who fail a preliminary exam twice will be asked to leave the PhD program. While not recommended, students are allowed to "retake" the exam on different topics, but they would only have a single opportunity to pass.

Additional details on the oral preliminary exam, including the rubric by which students are evaluated, is provided in Appendix A.

3.4.4 Comprehensive Examination

Students must complete a comprehensive exam at least 6 months prior to defending their PhD dissertations. At the time of the comprehensive exam, the dissertation committee will be formed and given preliminary approval by the Department and Graduate School.

A robotics PhD degree requires depth of knowledge in the dissertation/research area, as well as breadth of knowledge across the robotics curriculum. Consequently, the comprehensive exam is designed to test student knowledge of their proposed research area, and any general knowledge in the field. It is also intended to evaluate whether a student's proposed research project is original and creative work, whether it will make a significant impact in the field, and whether it will qualify for publication in quality peer-reviewed journals. The exam is also an opportunity to demonstrate an ability to present scientific concepts orally. In short, the comprehensive exam serves as the gateway to the next phase of the doctoral program: completion of a dissertation.

The comprehensive exam consists of the following core requirements:

- Complete the online Candidacy Application for Advanced Degree at least three weeks prior to your exam date.
- Email the exam committee information to robo@colorado.edu at least 3 weeks prior to your exam date. The committee must be approved by the Graduate School and the graduate advisor will initiate the doctoral exam report form on the student's behalf. The following details should be included in the email:
  - Student ID Number
  - Exam date
  - Committee member name
  - Committee member email address
  - Committee member department affiliation
- By email, send the comprehensive exam proposal to (*i*) the examining committee and (*ii*) the graduate advisors at robo@colorado.edu at least two weeks prior to the examination. The proposal should describe the work that has been completed to date and proposed work that will be completed for the dissertation.
- Included in the proposal should be a comprehensive literature review of the field of concentration, the subject of the dissertation, as well as a detailed timeline of work to be completed prior to the dissertation defense. In most cases, the proposal should be written in the style and format of the final dissertation document.

- Students must prepare a professional oral presentation that covers what is written in the proposal. This presentation should be 45-50 minutes in length and must be delivered at the comprehensive examination to the examination committee. The oral presentation portion of the examination is open to all students and faculty, and questions are entertained at the end of the presentation.
- The final part of the examination is restricted to only the student and the examination committee. During this portion, questions are entertained that cover the field of concentration and related fields.
- Successful candidates must receive affirmative votes from a majority of the members of their examination committee.

Students who fail the examination may attempt it once more after a period of time determined by the examination committee. Additional administrative requirements of the comprehensive examination are as follows:

- All program coursework must be completed before taking the comprehensive exam.
- Students must be registered as regular degree-seeking students when they take the comprehensive exam (thus requiring a minimum enrollment of 1 dissertation credit hour).
- Each comprehensive exam committee is comprised of five members. The program requires that three of the members be robotics program faculty.
- Each committee member must have a regular or special faculty appointment on file with the Graduate School prior to submission of the Doctoral Exam Report. Please contact the graduate advisors at robo@colorado.edu as soon as you form your committee, and no later than 6 weeks prior to your comprehensive examination, to verify that the necessary appointments are in place. It takes 2-4 weeks to process a faculty appointment. Students should submit a recent CV for any committee member who does not have a faculty appointment to the graduate advisors as soon as possible.

3.4.5 Dissertation Hour Requirement

In addition to coursework, PhD students are required to complete 30 PhD dissertation hours. Students are not able to register for dissertation credits on their own and should submit a request for dissertation hours through the Thesis/Dissertation Credit Hours Request Form.

The following Graduate School rules apply to enrollment in dissertation hours and should be considered when determining how many dissertation hours to register for each semester:

- PhD students must be registered as full time, regular degree-seeking students at CU for a minimum of 5 dissertation hours during the semester in which they defend the dissertation.
- A student may not register for more than 10 dissertation credit hours in any one semester, including summer.
- A PhD student is required to register continuously as a full-time student for a minimum of five dissertation hours in the Fall and Spring semesters of each year, beginning with the semester following the passing of the comprehensive examination and extending through the semester in which the dissertation is successfully defended.
- Prior to passing the comprehensive exam, PhD students are considered by the Graduate School to be full-time if they are registered for at least 1 dissertation credit per semester.

There is little advantage to a student registering for more than 30 dissertation hours during the course of their PhD, and so students should attempt to complete this requirement in the semester in which they defend. Please contact the graduate advisors at robo@colorado.edu for assistance with planning dissertation hour enrollment.

3.4.6 Written Dissertation

The written dissertation must comply with Graduate School rules and procedures in terms of format and submission. Full details on formatting requirements are available here, and deadlines and resources to assist in finalizing your dissertation are available here. Both Word and LaTeX templates for written dissertations are available here.

The dissertation title appears on official university transcripts and must be submitted to the Graduate School in addition to the physical signature page from the dissertation. Students are also required to submit the full written dissertation electronically at the ProQuest website. The timeline for these requirements is as follows:

- Final dissertation title submission is due about two months into the final semester.
- The oral dissertation defense must be passed shortly after this date.
- One week after the defense deadline, students must submit:
  - The written dissertation; and
  - The Thesis Approval Form, signed by the faculty advisor and one additional committee member.

3.4.7 Dissertation Defense

Before completion of the PhD degree, students must have their dissertation accepted for defense by the review committee. The dissertation defense may occur before or after the final electronic submission of the written dissertation to the Graduate School, but must take place prior to the end of the final semester of enrollment.

Students must then pass a dissertation defense, which is a final examination on the dissertation and related topics. In the defense, students are expected to explain their research clearly and concisely, and to discuss how it relates to other research in the field. This is an opportunity for recognition of completed doctoral work. It is also an opportunity for discussion and formal evaluation of the dissertation.

All required forms should be submitted on time according to the following deadlines:

- **To the Program:**
  - Email the exam committee information to robo@colorado.edu at least 3 weeks prior to your exam date. The committee must be approved by the Graduate School, even if there are no changes from the comprehensive exam committee. The graduate advisor will initiate the doctoral exam report form on the student's behalf. The following details should be included in the email:
    - Student ID number
    - Exam date
    - Committee member name
    - Committee member email address
    - Committee member department affiliation
- **To the Committee:** The written dissertation should be sent as a single pdf file by email to all members of the defense committee, as well as to the graduate advisors at robo@colorado.edu, at least 2 weeks before the defense. This deadline is intended to allow the defense committee sufficient time to review the dissertation and to formulate questions and feedback. Prior to the defense, students should contact all members of the committee to assess their areas of interest and concerns. This will help students anticipate any questions that will be asked.

Students must be registered as full time, regular degree-seeking students at CU for a minimum of 5 dissertation hours during the semester in which they pass the examination. The examination is conducted by a committee appointed by the chair of the Robotics Program and approved by the Dean of the Graduate School, and consists of at least five people with the following requirements:

- One committee member must be outside the Robotics Program;
- Three of the members must be Robotics Program faculty.

The chair of the committee must have tenure-track or tenured Graduate Faculty appointments. The other committee members must have either regular or special Graduate Faculty appointments. More than one dissenting vote disqualifies the candidate in the final examination.

Students should coordinate scheduling the examination with the committee, and should schedule the examination for two hours. The examination is wholly oral and open to the public for the first portion of the exami-

nation.

Students must prepare and present a professional oral presentation that summarizes the dissertation. This presentation should be 45-50 minutes in length and delivered to the examination committee. The oral presentation portion of the examination is open to all students and faculty. Questions are entertained at the end of the presentation.

The final part of the examination is closed to only the student and the examination committee. During this portion, questions are entertained that cover the field of concentration and related fields. More than one dissenting vote among the committee constitutes an unsatisfactory exam. A student who fails the exam may attempt it once more after a period of time determined by the committee.

3.5 PhD Student Status

As the requirements towards the PhD degree are completed, PhD students will advance from pre-preliminary exam, to post-preliminary exam, to post-comprehensive exam, status. Milestones required to achieve each status are the following:

- **Pre-comprehensive exam status (Pre-comps)**: Students enter the PhD program with pre-comps status and will typically remain at this status until successful completion of the comprehensive exam in year 4. Students should complete the required course (ROBO 5xxx: Intro to Robotics) and oral preliminary exam during this time.

3.6 Application for Graduation

To graduate with the PhD degree, students must complete all course and dissertation hour requirements, as well as write and defend their dissertation. Additional details on each of these requirements are provided above.

To graduate with the PhD degree, students must apply online through their Buff portal. Directions to complete this process can be found on the Registrar's website.

The application for graduation is due a few weeks after the start of the desired graduation semester. Full details on requirements and deadlines can be accessed on the Graduate School PhD graduation webpage. If you did not submit the Candidacy Application for Advanced Degree when completing the comprehensive examination, it must be submitted electronically prior to applying for graduation online.

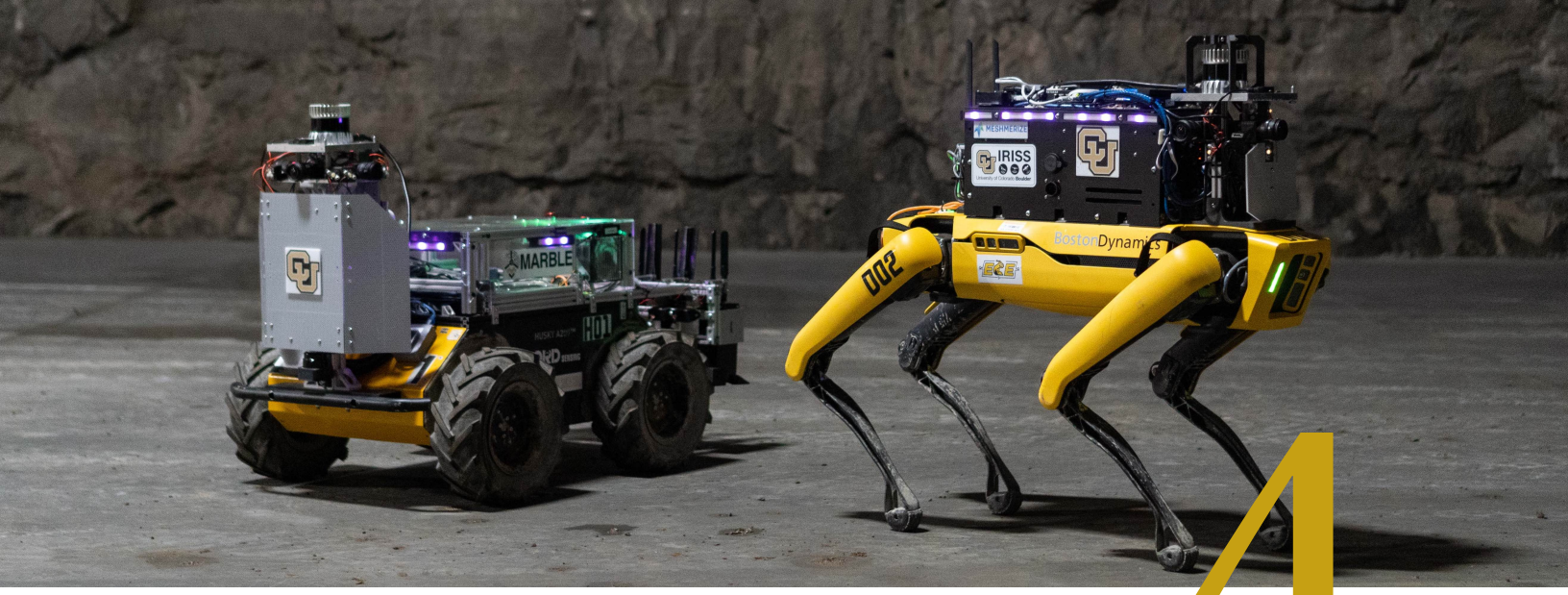
PhD students must be registered as a full time, regular degree-seeking student, for a minimum of 5 dissertation hours during the semester in which they pass the final exam. If a student is unable to meet the Graduate School's posted defense deadline for that semester, they should consult with their graduate advisor about graduation options.

Detailed graduation information will be communicated to all students through the graduate student listserv at the beginning of each semester.

The graduate program conducts an annual survey of PhD students that evaluates the overall PhD student experience within the mechanical engineering department over the previous academic year. The survey will be conducted anonymously and a report of results will be shared with faculty, staff and students within the department.

3.7 Master's Degree as a PhD Candidate

Although a Master's degree is not required for a PhD, students can earn one while working toward the PhD. This is accomplished by applying for an MS degree when 30 graduate course hours have been completed. All requirements described in Chapter 4 must be completed in order to receive the MS degree; the procedure to apply for graduation with the MS degree is also provided in this chapter. PhD students must notify their graduate advisor within the first two weeks of the semester in which they intend to graduate with the MS degree.



4 Master's Degree Programs

4.1 Overview

Master's degree students in Robotics take graduate courses and participate in research and/or project based learning as part of two different program choices, each leading to a master's of science (MS) degree in Robotics.

- **MS Non-Thesis Program:** This coursework-focused degree program emphasizes both project-based and curriculum-driven learning. It is targeted at working engineers and undergraduates considering, or already pursuing, a career in industry, but can also be completed with the ultimate goal of matriculating in a PhD program.
- **MS Thesis Program:** This program is intended for MS students interested in a short-term research experience, leading to the preparation and defense of a research-based thesis. The program emphasizes education through high quality research for students interested in careers in industry, the public sector, and academia.

Many incoming MS students will have prior degrees in some type of engineering, although students from other fields are also admitted and can acquire any missing background material during the course of their MS studies.

4.2 Mission Statement

The Robotics Graduate Program is committed to educating innovative, entrepreneurial, and fundamentally knowledgeable master's students who are prepared to excel—and lead—in their chosen professional careers after graduation, whether in industry, academia, or the public sector. This will be accomplished through high quality hands-on, project-based education in the classroom and in-depth training in the lab, as well as through extensive professional development opportunities offered by the department, college, and university. Through online, distance, and applied courses, the graduate program seeks to cater to current professionals and non-traditional students seeking to attain a master's degree. Each graduate of the master's program is a lifelong representative of CU and, as such, is expected to act professionally, ethically, and with integrity both during their time at CU and beyond.

4.3 Timeline

The majority of Non-Thesis MS students complete the requirements for the degree in 2 years of full-time study, although it is not uncommon to graduate in 3 semesters or to take more than 2 years, particularly if a student is also working full-time.

MS Thesis and dual degree students typically require at least 2 years to complete their degrees.

Full-time study is defined by the Graduate School as enrollment in 5 or more graduate credits per semester. Part-time study is permissible throughout the duration of the program, or for select semesters, as long as the following Graduate School requirements are met:

- Full-time enrollment for at least 2 semesters; or
- Part-time enrollment for at least 4 semesters; or
- Full-time enrollment for 1 semester and part-time enrollment in 2 or more semesters.

Master's students, whether part- or full-time, must complete their degree requirements within 4 years of their first semester of enrollment. If more time is needed, students can request a time-limit extension from the Graduate School by filing a time-limit extension via this online form. Please contact the graduate advisors at robo@colorado.edu for more information on requesting a time limit extension.

4.4 Requirements

4.4.1 Non-Thesis MS Degree Program

Students in the Non-Thesis MS degree program can enroll in any combination of coursework that they would like, and a list of Robotics graduate courses is provided on the program website here.

All MS Non-Thesis students must complete the following requirements to be eligible for graduation:

- **Plan of study.** Students must take 30 graduate-level credit hours of 5000+ level courses with at least a grade of C in each course. Masters students may petition to transfer as many as 9 credits of approved graduate level coursework not used towards another Masters degree. Students must maintain a cumulative 3.0 GPA to remain in good standing.
- **Introduction to Robotics.** Students must receive a grade of B or better (not B-) in ROBO 5000: Introduction to Robotics within their first year of enrollment. This course is offered every semester and prepares students to the remaining curriculum.
- **Breadth Requirements.** Students must receive a grade of B or better (not B-) in THREE graduate courses at the 5000-level, ONE each from THREE different BINS listed here. The purpose of this requirement is to assure the breadth of your knowledge in Robotics. This requirement must be met by all students.
  If you already have completed such a course at another school and have not used those credits towards a Masters degree, you can petition the graduate committee for approval of transfer of credits.
- **Remaining Coursework.** The remaining 18 graduate-level credit hours must be completed from the list available here.
- **Courses External to the Robotics Program.** Students may take up to 6 credit hours from other departments provided that those courses have "significant Robotics content" and are taught by a member of the graduate faculty. Students need not petition for the following non-ROBO graduate courses as long as they are within the College of Engineering and Applied Science.
  The student must file a petition to allow any other courses to be counted toward the degree. This petition must explicitly verify the above requirements and must be approved by the student's advisor and the Graduate Director of the Robotics program. You should seek approval for any out of program classes before the add/drop deadline. When considering out of program course, consider the following guidelines:
  - They must not be Robotics or very similar to a course available in ROBO.
  - They must not be cross-listed with ROBO.
  - They must have significant Robotics content.
  - The instructor must be a member of the Graduate School faculty
  - You will ALWAYS need to file a petition to the graduate committee.
  - You should discuss with the graduate advisor before the add/drop deadline.

4.4.2 MS Thesis Degree Program

In order to enroll in the MS Thesis program, students must first secure a thesis advisor. Once an advisor has

been found, students may be admitted into the MS Thesis program from the Non-Thesis MS or PhD program by following the procedures outlined in Section 2.5.

MS Thesis students should consult with their thesis and graduate advisors for course selection recommendations. Students in the MS Thesis program can enroll in any combination of coursework that they would like, and a list of Robotics graduate courses is provided on the program website here.

MS Thesis students must complete the following requirements to obtain the MS degree:

- **MS Degree Requirements.** Students must fulfill other MS Degree requirements as listed in Section 4.4.1.
- **MS Thesis.** 6 credits of MS thesis hours (ROBO 6xxx) must be completed, typically in the final two semesters of the program. Students are not able to register for MS thesis credits on their own and should submit a request for thesis hours through the Thesis/Dissertation Hours Enrollment Request Form.
- **Thesis Advisor Selection.** Upon finding a research advisor, MS Thesis students should complete the MS Thesis Research Expectations Form. This form should be completed no later than the end of the first semester of enrollment in the MS Thesis program.
- **Written Thesis.** The written thesis must comply with Graduate School rules and procedures in terms of format and submission. Full details on formatting requirements are available here, and deadlines and resources to assist in finalizing your thesis are available here.
  Students are required to submit the full written thesis electronically at the ProQuest website. The timeline for these requirements is as follows:
  - The oral thesis defense must be passed about 2/3 into the last semester.
  - One week after the defense deadline, students must submit:
    * The written thesis, electronically; and
    * The physical signature page, signed by all committee members, to the Graduate School.

    Both of these items can be completed using the form provided here.
- **Thesis Defense.** Students must pass a thesis defense, which is a final examination on the thesis and related topics. In the defense, students are expected to explain their research clearly and concisely, and to discuss how it relates to other research in the field. This is an opportunity for recognition of completed MS Thesis research. It is also an opportunity for discussion and formal evaluation of the thesis.
  The thesis defense may occur before or after the final electronic submission of the written thesis to the Graduate School, but must take place prior to the end of the final semester. Failure to defend prior to the end of the proposed final semester may result in the need to register for additional course credits during another semester.
  All required forms should be submitted on time according to the following deadlines:
  - *To the Department:* The Master's Examination Report should be submitted to your graduate advisor at least 3 weeks prior to the defense.
  - *To the Committee:* The written thesis should be sent as a single pdf file by email to all members of the defense committee, as well as to the graduate advisors at robo@colorado.edu, at least one week before the defense. This deadline is intended to allow the defense committee sufficient time to review the thesis and to formulate questions and feedback. Prior to the defense, students should contact all members of the committee to assess their areas of interest and concerns. This will help students anticipate any questions that will be asked.

  Students must be registered as full time, regular degree-seeking students during the semester in which they pass the examination. The examination is conducted by a committee appointed by the thesis advisorand approved by the Dean of the Graduate School, and consists of at least three people, two of which must be ROBO faculty.
  The chair of the committee must have a regular or tenured Graduate Faculty appointment. The other committee members must have either regular or special Graduate Faculty appointments. Please contact the graduate advisors at robo@colorado.edu as soon as you form your committee, and no later than 6

weeks prior to your examination, to verify that the necessary appointments are in place. It takes 2-4 weeks to process a faculty appointment. Students should submit a recent CV for any committee member who does not have a faculty appointment to the graduate advisors as soon as possible.
Students should coordinate scheduling the examination with the committee, and should schedule the examination for one hour and a half. The examination is wholly oral and open to the public for the first portion of the examination. Students must prepare a professional oral presentation that covers what was written in the thesis. This presentation should be 45 minutes in length. This presentation shall be delivered at the final examination to the examination committee. The oral presentation portion of the examination is open to all students and faculty. Questions are entertained at the end of the presentation. The final part of the examination is closed to only the student and the examination committee. During this portion, questions are entertained that cover the field of concentration and related fields. More than one dissenting vote among the committee constitutes an unsatisfactory exam. A student who fails the exam may attempt it once more after a period of time determined by the committee.

4.4.3 Transfer Credit

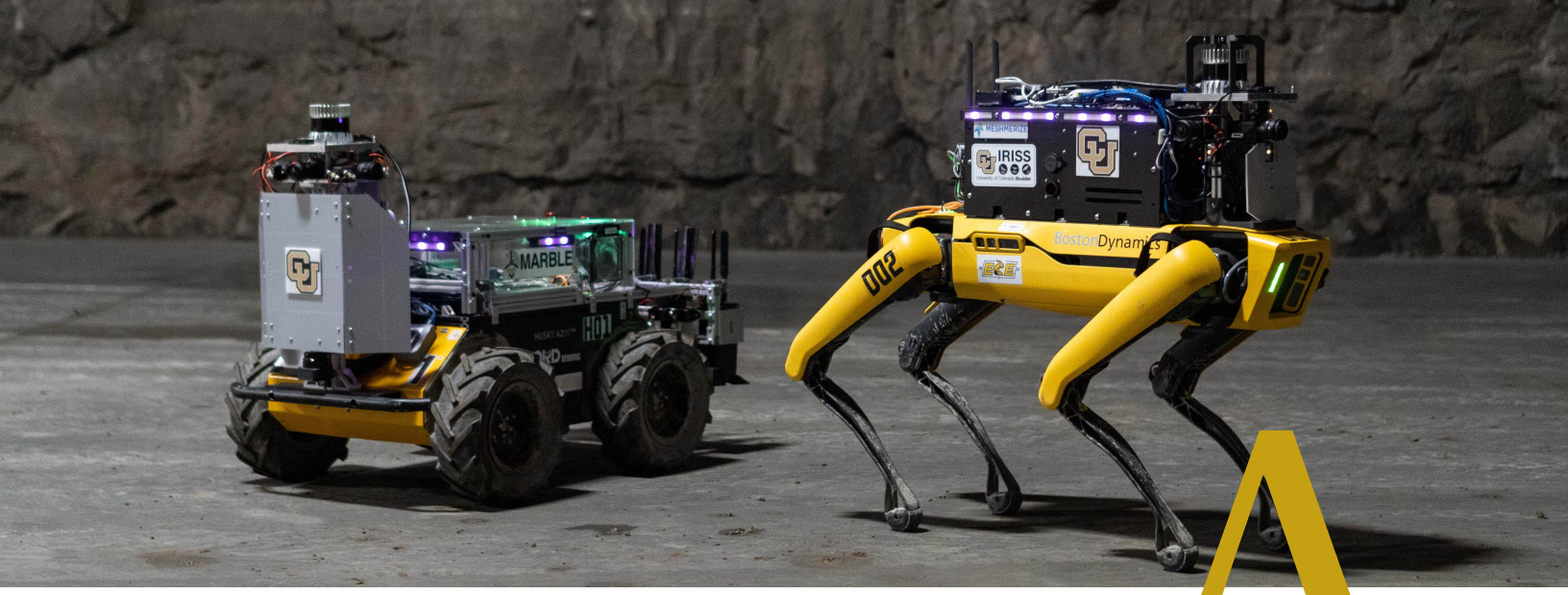
Students may be eligible to transfer up to 9 hours of coursework to meet the Master's degree course requirements. More information is available on the Request for Transfer of Credit Form from the CU Graduate School. To transfer credits, students must fill out and submit this form to the Graduate School via DocuSign.

Please note that requests for transfer credit can only be made after completing 6 credits of graduate level coursework at CU. These requests should be submitted as soon after completion of this 6 credit requirement as possible. Typically, this means that transfer of credit requests are processed during the second semester of study at CU.

4.5 Application for Graduation

In order to graduate with the Master's degree, students must apply online through their myCU portal. On the "Student" tab, select the "Apply for Graduation" link under "Academic Resources".

The application for graduation is due a few weeks after the start of the desired graduation semester. Full details on requirements can be accessed by clicking on the appropriate program at this webpage, and deadlines are available by selecting the appropriate semester for graduation on this webpage. For all degree programs, the Candidacy Application for Advanced Degree must be submitted to the Graduate School via DocuSign. Detailed graduation information will be communicated to all students through the graduate student listserv at the beginning of each semester.



Oral Preliminary Exams

A

A.1 Oral Preliminary Exam Guidelines

Oral preliminary exams for PhD students should be completed sometime during their third semester in the robotics PhD program. These exams are focused on assessing understanding of fundamental knowledge, on-the-spot technical communication skills and practical preparation for a research intensive program. The exams are oral in order to prepare students for comprehensive exams, PhD defenses, conference presentations, job talks, TA duties, and teaching, all of which require oral communication.

A.1.1 Format

The exam itself is oral, will be about an hour long, and is delivered by a committee of three faculty. Students and faculty advisors are responsible for scheduling the preliminary exam. When scheduling the exam, students and faculty advisors should reserve an hour and fifteen minutes to allow time for both the exam itself and for committee deliberation afterward. Once the exam has been scheduled, the Graduate Program Assistant should be notified and initiation of the preliminary exam form requested. The preliminary exam committee cannot include the student faculty advisor (the advisor may sit in on the exam to observe the student's performance, but will not participate in the committee's discussion and evaluation).

The student begins with a fifteen-minute timed talk about an area of research they could initiate, followed by five minutes of question-and-answer time with the committee. The topic need not be the student's final PhD dissertation topic, and explicitly does not require faculty advisor input. Slides for this portion of the exam are allowed and encouraged. The remaining forty minutes of the exam is composed of up to four questions on specific topics (see below) that are prepared in advance, so that all students answer the same questions. The goal of this portion of the exam is to interrogate knowledge of fundamentals in each topic area plus 'on the fly' deeper questions such as applicability and limitations of the theory.

Students will be notified by the exam committee with its final decision (pass/fail/conditional pass) following the exam. The exam committee will consult the student's advisor on its recommendations in the event of a conditional pass or failure. Those receiving conditional or failing evaluations are strongly encouraged to meet with the topical exam faculty lead to discuss the results; those passing are also encouraged to meet with the exam committee faculty for additional feedback.

A.1.2 Oral Preliminary Exam Topics

All PhD students are required to test in two different breadth courses, where one breadth course shall be selected from two of the three breadth bins posted on the Robotics Graduate program website. Students are

strongly encouraged to take recommended preparatory courses for each focus area topic prior to taking the oral preliminary exam (although they are not required to do so). The recommended course list may change periodically and will be posted on the Robotics Program website.

A.1.3 Rubric and Outcomes

- Pass
  - Student correctly answers at least 75% of questions posed in the exam
  - Student communicates technical concepts with minimal assistance from examiners
  - Student clearly articulates the research area, motivation, prior work, gaps, coherent proposed plan with specific steps
- Conditional Pass (examiners recommend additional work/courses to supplement knowledge)
  - Student correctly answers 50% of the questions posed
  - Student communicates technical concepts with some assistance from examiners
  - Student leaves questions about the research area, motivation, prior work, gaps; somewhat coherent proposed plan
- Fail (committee chair talks with advisor about mitigations, one reattempt allowed) Student correctly answers less than 50% of questions posed in the exam
  - Student has difficulty communicating technical concepts and requires significant assistance from examiners
  - Poorly structured talk, student jumps directly to what they want to try, no discussion of prior work, no specific plan/steps

To provide time to identify any potential biases or problems with each exam, final decisions are not delivered to students immediately after each exam. Once all exams are completed, all committee members for each exam will meet to discuss scores and determine final decisions. In the event of a conditional pass or failure, the committee will consult the student's advisor regarding recommended next steps

Final decisions are communicated to students by email after all exams have been completed. For each exam taken, students receive their final decision (i.e., pass, fail, or conditional pass) and a written explanation of the decision. If a student receives a conditional pass, the condition placed on the student is also described. All students who receive a conditional pass or failing grade on any exam are required to meet with either the graduate program chair or the lead faculty for that exam. Students who pass an exam are not required to attend any additional meetings, although they are given the option to meet with the graduate program chair or lead faculty if desired.

Students who struggle on an oral preliminary exam but demonstrate potential for success in the PhD program may receive a conditional pass. A conditional pass can take many forms, including (but not limited to) taking an additional course, guest lecturing for a course, completing an additional report or assignment, or repeating a specific portion of the oral. In general, the condition imposed on the student is intended to address areas identified as needing improvement during the oral exam. Once the condition is satisfied, the student is considered to have completed their oral preliminary exam(s).