Carnegie Mellon University

Master's Student Handbook

2026-27 Academic Year

School of Computer Science

The Robotics Institute

Graduate Student Handbook

Master of Science in Robotics (MSR)

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Welcome & Introduction

We are proud of the open, friendly culture that has been the hallmark of the Robotics Institute (RI) since its inception. Faculty keep their office doors open to encourage informal meetings with students and colleagues. Graduate students organize department-wide social activities, ranging from Friday afternoon get-togethers to rock climbing trips. In addition, the department's strong support for collaboration creates an ideal environment for world-class robotics research.

RI is an intellectually diverse, multi-disciplinary department. Our faculty and students come from a wide variety of backgrounds and represent many unique areas of expertise. This diversity stems from the multi-faceted nature of robotics, which encompasses aspects of computer science, mechanical engineering, electrical engineering, psychology, and many other disciplines.

RI was established in 1979 to conduct basic and applied research in robotics technologies relevant to industrial and societal tasks. Seeking to combine the practical and the theoretical, RI has diversified its efforts and approaches to robotics science while retaining its original goal of realizing the potential of the robotics field.

RI is an international leader in robotics education. The world's first Robotics Ph.D. program was founded here in 1988 with the goal of providing graduate students with the knowledge, experience, and skills to become the next leaders in robotics research and education. Graduates from the Ph.D. program have taken on roles ranging from faculty in top universities, to designing and controlling Mars rovers, to developing self-driving cars. We have steadily grown and expanded our programs of study over the years.

Today, we offer diverse opportunities at all levels of education - from master's programs and an undergraduate degree to K-12 where our renowned programs, workshops, and summer classes inspire and educate the next generation of roboticists. Even when robotics technologies were relatively primitive, their ability to boost the productivity and stature of the United States was foreseen in the evolving global marketplace.

Best Wishes,

Dr. Srinivasa Narasimhan
Interim Director, Robotics Institute

While this handbook is specific to your academic experience in the department, it is just one element of the Graduate Student Handbook Suite. Here are several other resources within the suite that you should consult when needed:

- The Appendix for your specific program at the end of this Handbook
- University-Wide Graduate Student Handbook: Office of Graduate & Postdoctoral Affairs>Resources
- CMU Graduate Student Handbook

2. Robotics Institute Vision, Mission, and Values

2.1: Vision

Since its founding, the Robotics Institute (RI) at Carnegie Mellon University continues to be the preeminent collaborative hub for the world's visionaries in robotics. As the pioneers of computer science-based robotics, our approach to research, development and implementation is rooted in interdisciplinarity and is guided by computational thinking, so that we may build premiere real-world solutions that serve the breadth of humanity.

2.2: Mission

RI brings together the top scientific minds, intent on solving humanity's toughest challenges through robotics. Encompassing the practical and the theoretical, we push the boundaries of collaboration to develop interdisciplinary solutions touching nearly every aspect of human life—making things safer, more efficient and more productive. We educate, mentor and empower the brightest and most ambitious roboticists to anticipate the future, and then to build the robotics we need to take us there.

2.3: Values

Every voice matters and creativity and ingenuity thrive.
All individuals are welcome. All ideas are significant. All points of view are critical. Our influence is amplified by the people who choose to be here. We cultivate sheer talent and brilliance to produce the robotics leaders the world needs.

What we build has the power to change almost anything for good.
Our sense of responsibility guides and unites us. Because we have the capabilities and technologies to offer a brighter future, it's on us to find solutions and fuel essential progress.

We're always the revolutionaries of robotics.
For decades, we've been intrepidly driving the field forward—for the betterment of society and the lives of people everywhere.

Together, even moonshots are within our reach.
At the intersection of collaboration, ambition and hard work, we believe anything is possible.

3. Degrees Offered

Doctor of Philosophy (Ph.D.) in Robotics
Master of Science in Robotics (MSR)
Master of Science in Robotic Systems Development (MRSD)
Master of Science in Computer Vision (MSCV)
Bachelor of Science in Robotics (BSR)

4. SCS & RI Department Personnel

As already mentioned, we are proud of the open, friendly culture that has been the hallmark of the Robotics Institute (RI) since its inception. Faculty keep their office doors open to encourage informal meetings with students and colleagues. Graduate students organize department-wide social activities, ranging from Friday afternoon get-togethers to rock climbing trips. In addition, the department's strong support for collaboration creates an ideal environment for world-class robotics research. Feel free to reach out to anyone in the RI department and/or School of Computer Science (SCS) as needed.

Upper Level Leadership		
Dean, School of Computer Science	Martial Hebert	Dean of SCS
Associate Dean for MS Programs	David Garlan	Dean for SCS MS students
Interim Director, RI Research Professor	Srinivasa Narasimhan	RI Director
RI Education Leadership		
Director of Education, RI MSR Program Chair Research Professor	George Kantor	Leads educational initiatives, Ombudsperson MSR elective /program approvals
PhD Program Chair Research Professor	David Wettergreen	PhD student support, Ombudsperson
MRSD Program Chair Principal Systems Scientist	John M. Dolan	MRSD Internships, projects, career advising
MSCV Program Chair Associate Professor	Michael Kaess	MSCV Internships, projects, career advising
Manager, RI Education Team	Barbara Jean (B.J.) Fecich	Leads Education Team, Student advocate and support
MSCV / MRSD Program Manager	Sarah Conte	MRSD/ MSCV student support
MSR Program Manager	Angelica Bondy	MSR student support
PhD Program Manager	Becky Wang	PhD student support
Senior Academic Coordinator	Kaylan Conner	BSR / Undergraduate student support RISO Point of Contact
Senior Academic Service Officer	Jean Harpley	Course scheduling, RI waitlists, TAs
RI Business Office and Administrative Staff		
Assoc Dir Finance & Administration	Cheryl Wehrer	Administrative and business oversight
Senior Administrative Coordinator	Tracy Linza	Funding coordinator
Administrative Assistant / Receptionist	Victor Valle	RI Mailroom, access to Robolounge, etc
Additional Resources		
SCS Computing Facilities	help@cs.cmu.edu	Printing, technology assistance
SCS HUB / Student Accounts Liaison	Marian Mirchandani	Financial aid, billing
Community Health & Well-Being	Angie Lusk	Student Affairs Liaison for SCS

5. Departmental Resources

Bulletin Boards: Students are welcome to post flyers, advertisements, etc. to any bulletin board in Newell Simon Hall (NSH) common spaces (i.e., outside of elevators). RI Graduate students may use e-mail distribution lists to communicate messages to one another. Information about email distribution lists can be found in the Roboguide.

Mail: The RI mailroom is located on the fourth (4th) floor of Newell-Simon Hall (NSH). Please follow these Roboguide instructions for sending + receiving packages.

Department Computer Clusters: Students should use the on-campus computing facilities offered by Computing Services. Students should adhere to the Computing Policies and Guidelines.

Copy Machine Availability: As a courtesy, RI Graduate students have access to the machine on the 4th floor of NSH. Students must use their password to log in; then they can print, make copies, scan documents, and send faxes. Any issues with the copy machine should be promptly reported to Becky Klaas. Questions about connecting to printing are to be directed to SCS Help.

Students may also use public "Andrew" printing. All campus affiliates are allotted a per-semester print quota which is debited as you print. Some locations offer color printing and special paper sizes. Instructions on installing the print drivers and other questions can be found here. General instructions for using printers and copiers can be found here.

Workspace: RI master's students are welcome to use the RoboLounge (NSH 1512), the HIVE (NSH 1502), NSH 4228, and other SCS common spaces in Newell-Simon Hall (NSH) and Gates Hillman Centers (GHC). Please review the Graduate Student Space webpage on the RoboGuide for additional information, including which spaces are designated for specific activities (e.g., quiet study, eating, or group meetings), which rooms may be reserved, and instructions for making reservations.

Students may also use conference rooms after hours when they are not otherwise reserved. All students are expected to return shared spaces to their original condition after use.

Department Office/Building Security, Repairs and Services: The SCS Building Facilities group manages all initiatives and issues pertaining to the physical spaces occupied by the School of Computer Science, including RI. Please report any damages, needed repairs, and/or security concerns, both for routine requests and emergencies to this team.

Key/Access Card distribution and tracking: email building@cs.cmu.edu for an appointment. Valid CMU ID is required. Certain labs in SCS that handle their own key distribution. If you need a key for a

lab, please verify with the lab owner/personnel first. If you are locked out of your office after-hours, CMU Police can provide access. Call 412-268-2323. Any keys received from the RI Department, for any reason during your program should be returned upon an office move, degree completion, and/or when they are no longer needed.

Access card administration: Your CMU ID card will open the exterior doors of most CMU buildings after regular business hours and on weekends and holidays. However, you may also require access to departmental corridors on certain floors within SCS buildings. Stop by GHC 4107 or submit a request to get those access privileges. The nine-digit number from your CMU ID card is required to complete this process.
Lost CMU ID Card: the HUB handles ID Card and Plaid Cash services for the entire campus community. The HUB is in the lower level of Warner Hall. Visit their website for more information.

Purchasing and Reimbursement Procedures and Policies: CMU has detailed and strict policies relating to the purchase of goods, services, equipment, etc. whether using a general ledger account, restricted accounts and grants. There are also reimbursement policies, along with tax exempt considerations.

RI & SCS Graduate Student Organizations
The Graduate Student Assembly (GSA) is the branch of student government that represents all graduate students at CMU. GSA maintains an e-mail distribution list that students can subscribe to called GSA-Happenings. Your RI GSA representatives are elected "for life", which means once elected, the Reps can stay on till they graduate with an option to voluntarily "retire" anytime. RI's current representatives can be found here.

Women@SCS aims to create, encourage, and support academic, social, and professional opportunities for women in computer science and to promote the breadth of the field and its diverse community.

RISO is the Robotics Institute Student Organization. It organizes social events and trips, maintains the RoboLounge, and is also involved in the strategic long-term planning of RI. We encourage you to engage and volunteer with RISO as your interest and time allows. Please email RISO for more information.

Dec\5 is a social organization that encourages interaction between different Departments and Industry partners within SCS.

Department Approach to Press and Media Relations: The Senior Director of media relations in the SCS Dean's Office, Aaron Aupperlee, is the point of contact between news media and the School of Computer Science community, including faculty, students, administrators, and staff. He can assist

with strategic planning for publicity, interview preparation, and (depending on the specific project or issue) may assist in developing news stories or multimedia for the SCS website and social media channels.

Department/College/University Brands and Logos

The CMU Brand

RI Department Branding and Identity information: see Roboguide

6. Advising

6.1: Role of an Advisor and Advisor Assignments

RI graduate students receive advising and support from their Program Chair, Program Manager, and, for PhD students, their research advisor.

In general, advisors provide guidance, support, and resources to help students navigate their academic and research experience. However, students are ultimately responsible for managing their own academic progress and ensuring the timely completion of all degree requirements. Students are encouraged to seek guidance from faculty members and other appropriate resources for specialized technical or research advice as needed

6.2: Advisor/Advisee Collaboration

Your advisor's role may change over the course of your graduate studies. It can include advising on classes, research methods and processes, writing, publication process, conference presentations, thesis writing and presentation and a job search. You and your advisor will mutually agree upon meeting frequency, meeting purpose, required meeting preparation and any other guidelines necessary to ensure a successful relationship.

Suggested topics you may want to review with your advisor(s):

- How research project assignment will be made
- Reporting requirements, including responsibility for budgets and appropriate charges
- Safety requirements in laboratories and studios
- Management of support staff- undergraduates or new graduate students,
- All publication expectations and processes- decisions of authorship lineup, writing responsibilities, determination of when a publication is ready for submission
- Faculty's responsibility for monitoring the integrity with which the research is carried out
- Your responsibility for accurate record keeping and the ethical responsibilities of your research endeavors

1. Conference funding/ travel resources
2. Determination of submission of abstracts for presentation or publication
3. How decisions will be made about who represents the research at conferences, and the protocols of representing Carnegie Mellon at conferences.

Respect and confidentiality

Remember to maintain the confidentiality of research projects and publications. All Master's students are expected to respect the principle of confidentiality among and between group members.

Communication is KEY

Maintain open lines of communication, respond to one another in a timely fashion, address conflicts respectfully and seek guidance when needed, clearly define timelines and expectations.

6.3: Review/Redress of Academic Conflicts

RI Graduate students who feel the need to address academic concerns should start with specific Program representatives and escalate as necessary.

Program Level: **Start HERE**	RI Department Level: 2nd	SCS Level: 3rd
Program Chair Program Manager	Manager, Education Team Associate Director of Education Department Director	Associate Dean SCS Dean

George Kantor and David Wettergreen serve as ombudspersons for graduate students to assist with difficult academic or personal situations where a confidential sounding board and/or an intermediary can be helpful. Feel free to reach out to them directly. Examples of situations where students are encouraged to seek advice or assistance include:

- Difficulty in communications with advisors, particularly when those difficulties may lead to considering changing advisors or leaving the program.
- When conflict with other group members is difficult to resolve within the group.
- Issues related to diversity or the departmental climate for those in groups who are historically underrepresented in science.
- Personal concerns that interfere significantly with the ability to make timely progress in research or program requirements. These might be due to health, family, or financial challenges.

7. Graduate Degree Requirements

7.1: Residency Requirements

Students are required to complete the course requirements in their entirety at the Carnegie Mellon University - Pittsburgh campus. RI does not offer an option for distance learning. Students are required to be present on campus to complete all course requirements. In addition, U.S. government regulations require F-1 and J-1 international students to be enrolled in an in-person degree program, with in-person coursework. RI students may be enrolled in only one graduate program at a time.

7.2: Registration Process

Students are responsible for managing their registration via Student Information Online (SIO) portal.

7.3: Required Units for Degree Attainment

Unit requirements for a degree in RI vary depending on the program you are admitted to. See your program appendix for clarification.

7.4: Policy on Double Counting Courses

Students in an RI graduate program are prohibited from double-counting courses. A course may only be counted towards one requirement within one degree. Exceptions are made for RI PhD students obtaining an MSR degree while pursuing their PhD.

7.5: Policy for Courses Outside the Program Curriculum

Graduate program curriculums are designed to occupy a student's full-time effort. Due to the intensive and collaborative nature of the program, the RI Department will not permit students to take more than the units required for program progression /degree completion. The maximum number of units permitted is set at the program level and cannot be raised. Courses that are audited or taken pass/ no pass are included in the unit max, max units will not be increased to allow a student to audit or pass/no pass a course.

7.6: Teaching Requirements/Opportunities

All interested students are required to have a certain level of fluency in English before they can instruct in Pennsylvania, as required by the English Fluency in Higher Education Act of 1990. Through this Act, all institutions of higher education in the state are required to evaluate and certify the English fluency of all instructional personnel, including teaching assistants and interns. View the full university policy here.

The fluency of all instructional personnel will be rated by Language Support in the Student Academic Success Center to determine at what level of responsibility the student can TA. In addition to administering the International Teaching Assistant (ITA) Test (a mandatory screening test for any non-native speaker of English), Language Support in the Student Academic Success Center helps teaching assistants who are non-native English speakers develop fluency and cultural understanding to teach successfully at Carnegie Mellon.

7.7: Requirements for Program Application

Requirements necessary to apply to a graduate program within the Robotics Institute vary depending on the program. See program appendix for program specific details.

7.8: Course Categories

Core Course: A core course is one that satisfies a core requirement for one or more RI degree programs (PhD, MSR, MRSD, MSCV). Core courses are offered at least once per year and offered in consistent semesters so students can plan accordingly (e.g., a core class is offered every Spring, it does not frequently switch between Spring and Fall). The course has lectures and multiple graded assessments (problem sets, quizzes, exams, projects, etc.).

Regular Course: A regular course has an established curriculum and is taught on a regular schedule, at least once every two years. The course has lectures and multiple graded assessments (problem sets, quizzes, exams, projects, etc.). If the faculty member who usually teaches a regular course is unavailable in the semester when the course is usually offered, RI will try to offer the course with a different instructor, but if one cannot be found the course will not be offered that semester. Regular courses can be used to partially satisfy the PhD specialized qualifier.

Special Topics Course: A special topics course is a new or experimental course where there is no commitment to offer on a regular basis. The course has lectures and multiple graded assessments (problem sets, projects, etc.). If the faculty member who usually teaches a special topics course is not available to teach it in a given semester, it is not offered that semester (i.e., no attempt is made by RI to find a substitute instructor). Special topics courses may be transitioned to regular courses with and assigned a permanent course number if they have been offered for two consecutive years, maintained significant enrollment, and have a commitment from the instructor to regularly offer the course. Special topics courses can be used to partially satisfy the PhD specialized qualifier.

Seminar Course: A seminar course is one that is created by an instructor in order to explore a contemporary research topic. Seminar courses may have some instructor-led lectures, but the primary activity in the course is reading, presenting, and discussing papers. Seminar courses do not have formal assessments beyond class participation. Seminar courses sometimes evolve into courses with a more formal curriculum by adding lectures and assessments. When this happens, a seminar may be converted to a special topic or regular course. Seminar courses cannot be used to partially satisfy the PhD specialized qualifier, nor are they pre-approved as electives for MSR, MRSD, MSCV programs.

Challenge Course: A challenge course is one that is created by an instructor to organize a student team to compete in an externally organized challenge program. Challenge courses may or may not have formal lectures. Challenge courses must have stated learning objectives and student performance assessments, but these can be more loosely defined than those of regular courses. Challenge courses are offered during the time when the external challenge is active and are expected to stop being offered when the challenge is completed. Challenge courses can be used to satisfy at most one course in the PhD Specialized Qualifier. In Master's programs, challenge courses may be used to satisfy at most one elective.

	Satisfies requirements	Offer frequency	Curriculum	TAs	Course number
Core Course	core	every year	lectures and assessments	normal schedule	Permanent
Regular Course	electives / PhD specialized qualifier (SQ)	at least once every 2 years	lectures and assessments	normal schedule	Permanent
Special Topics	electives / PhD specialized	not offered regularly	lectures and assessments	normal schedule	Temporary, prepend "Special Topics:"

	Satisfies requirements	Offer frequency	Curriculum	TAs	Course number
Course	qualifier (SQ)				
Seminar Course	not for PhD specialized qualifier (SQ); with approval for MS	not offered regularly	read and discuss papers	none	Temporary, prepend “Seminar:”
Challenge Course**	Limit of one as elective or PhD specialized qualifier (SQ)	offered during challenge	pursue challenge tasks	normal schedule	Temporary, prepend “Challenge:”

**Courses offered in the past that would qualify as a Challenge Course include 16-663 (F1Tenth Autonomous Racing) and 16-873 (Spacecraft Design-Build-Fly Laboratory). Going forward, eligible RI challenge courses will be identified as such in their course descriptions.

8: Department Policies & Protocols

8.1: Department Policy for Withdrawing from a Course

Students taking undergraduate and/or graduate level courses must follow the procedures and deadlines indicated by the Registrar's Office for adding, dropping, or withdrawing from courses as identified on the academic calendar. NOTE: There is a separate calendar for doctoral-level courses.

8.2: New Policies / "Grandfather" Policy

When policies are changed it is because the department believes the new rules offer an improvement. Currently enrolled students whose degree program is affected by a change in policy may choose to be governed by the old policy that was in place at the time of their matriculation or the new policy. In case degree requirements are changed and certain courses are no longer offered, the department will try to find some compromise that allows those students to satisfy the original requirements.

8.3: Time Away from Academic Responsibilities

RI graduate students should not assume that their time away from academic responsibilities follows the academic calendar. While academic breaks may provide opportunities for time away from coursework, many graduate programs, including research-based programs, have an expectation that students will continue making progress on their research throughout the year.

Expectations regarding time away from campus and academic responsibilities may vary depending on a student's research activities and should be discussed with the student's faculty advisor. If a student's research responsibilities regularly require time commitments beyond a typical weekday schedule, these expectations should be clearly communicated.

University Holidays are considered student holidays. However, some research activities, such as experiments that require continuous monitoring, may require arrangements for coverage during a University Holiday. Students should discuss these circumstances with their faculty advisor in advance and make appropriate arrangements. When students are required to work on a University Holiday, they should work with their faculty advisor to arrange an equivalent amount of time off at another mutually agreed-upon time.

8.4: RI Department Bereavement Policy

Students are eligible for protected bereavement leave if they experience the loss of an immediate family member. "Immediate Family" includes, but is not limited to, a spouse or registered domestic partner, child/stepchild/unborn child, parent/stepparent, sibling/step-sibling, grandchild, grandparent, parent-in-law/parent of registered domestic partner, and sibling-in-law/sibling of registered domestic partner.

Under this leave, full-time and part-time students are excused from class for at least five (5) working days for each eligible death. These days may be used non-consecutively. Full-time and part-time students are also absolved of research duties while on leave and are eligible to continue receiving any uninterrupted pay related to the relevant funding support during this period if they are funded.

Additional Travel Days

In addition to the excused academic days, students may request up to three (3) additional working days of leave to account for travel considerations. Please see “Process and Notification” for more details on how to request this additional time.

Process and Notification

Arrangement and approval of leave and extension of assigned work should begin as soon as you learn of the death of a member of your immediate family. Students should notify their academic advisor, who can help coordinate with course instructors about the student’s absence on their behalf. Students should additionally contact their research advisor.

Stipulations

While this policy excuses a student from class attendance, the student remains responsible for all material covered in class and must work with each individual professor upon return to complete any required work. Graduate students are similarly expected to work with their research advisor to ensure that they get back on track with their research upon their return.

Students should also note that, while advisors will make every effort to assist students in getting their leave fully approved, subject to the requirements for their courses/research; whether or not the policy is followed may be subject to the discretion of the course instructor/research advisor.

Additional Leave

The total time of the bereavement leave should be agreed upon by the student and their teaching/funding professors based on their needs and circumstances, with the minimum offered time set at five (5) working days (with additional travel days as needed). Possible considerations for duration include, but are not limited to, physical recovery (in the case of additional injury or recovery after stillbirth), and accommodation for new and resultant arrangements (childcare, managing the estate of the deceased, etc.).

Should the student need leave of more than five (5) working days, or any other support, they are encouraged to reach out to RI Cares representatives in the department and/or their research advisor to work out accommodation.

9: Grading & Evaluation: See Program Appendix

9.1: Satisfactory Academic Standing

Any student who fails to achieve the minimum QPA, infringes the Academic Integrity policy, or otherwise fails to make appropriate progress toward graduation, falls out of Good Standing in the Program. Academic integrity on research papers, including a dissertation, is also enforced strictly; citations are required to avoid plagiarism, including self-plagiarism.

The first time a student falls out of Good Standing, the student is subject to Academic Probation, which serves as a warning to the student and may also trigger supportive actions on the part of the Program, such as advising meetings, reduced maximum course loads, and/or ineligibility for Research Assistantship funding.

If after one semester the student has not returned to Good Standing, or should a student fall out of Good Standing more than once during the Program, the student is subject to Academic Suspension, which is a mandatory, but temporary, leave from the University. It serves as an opportunity for the student to re-evaluate goals, reflect on the requirements for success, and return to the University better prepared to succeed.

Any student previously placed on Academic Suspension who fails to remain in Good Standing may be dismissed from the program (i.e., expelled). Dismissal indicates a complete and permanent separation of the student from the Program.

Elevated levels of misconduct, either within or outside of a class setting, may upon recommendation by the Chair of the Program and confirmation by the RI Associate Director of Education and the RI Department Head, result in Academic Probation, Suspension, or Dismissal, potentially during a semester.

Students will receive official notice of academic actions, such as the imposition or removal of probation, in the form of a letter mailed to the “permanent address” on file with the University. The Department Head’s determination may be appealed, however, will remain in effect during the appeal. Please refer to the CMU Summary of Graduate Student Appeal and Grievance Procedures should you wish to appeal any/all decisions.

10: Funding & Financial Support

10.1: Travel/Conference and Research Funding

The RI Department does not provide funds for travel or conferences. Funds are available for students to attend a conference, whether as a participant or as a presenter, from GSA and the Provost’s Office.

The application process is managed by the Office of Graduate and Postdoc Affairs. Students can find more information about the application process and deadlines here.

10.2: Department Policy on Outside Employment

Due to the time-consuming nature of RI Graduate Program studies, students are not advised to accept employment while enrolled in the program as a full-time student. International students must contact the Office of International Education regarding their ability to hold employment.

Carnegie Mellon University

Master's Student Handbook

2026-27 Academic Year

Master of Science in Robotics (MSR)
Appendix

Master of Science in Robotics (MSR) Degree Requirements

The MSR requires completion of a minimum of 168 units. Of these total units, at least 84 units must comprise core and elective coursework, and at least 84 units must be supervised research (16-997). The 168 units for the MSR degree may not double count for another undergraduate or master's program.

The course and research requirements are performed concurrently and are to be completed in twenty-four months. (Two academic years and two summers.)

The exact degree requirements for a student in the program are as defined in the handbook as of the date that student first enrolls in the Robotics MS program. Any subsequent changes to the program requirements may optionally be selected by the student, or the student may choose to retain the previous requirements.

1.1 Background Requirements

The MS in Robotics program accepts strongly motivated and exceptionally talented students from a wide range of educational backgrounds. It is each student's personal responsibility to arrive with, or to acquire rapidly thereafter, basic understanding (at the level of an introductory undergraduate course) in the following areas:

- Mathematics: calculus, linear algebra, numerical analysis, probability, and statistics
- Computer Science: programming, data structures, algorithms
- Physics and Engineering: mechanics, dynamics, electricity and magnetism, optics

On request, the faculty will advise incoming students about individually appropriate alternative ways to satisfy these requirements, e.g., taking an undergraduate course, serving as a TA in an undergraduate course, or self- study by guided reading and discussion.

1.2 Core Courses

Research Core Course

A minimum of 84 units of supervised research (16-997) credit is required to graduate. Additional details are outlined in the Research Requirements section below.

Academic Core Courses

All of the necessary courses must be passed with a grade of a B-, or better, to fulfill, or contribute to, completion of the MSR requirements.

If admitted into the RI PhD program, the core courses taken during the MSR program can be used towards the core requirements of the PhD program with PhD Program Chair approval (except for 10-601).

Robotics research revolves around four core areas of knowledge, including:

- Sensing and Perception: The observation and interpretation of a robot's environment as well as its own state.
- Thinking about Actions: The conception and selection of actions through planning, learning and control.
- Robot Embodiment: The design and realization of the physical robot.
- Environment Interaction: The interaction of a robot with its environment, whether animate (human robot interaction) or inanimate (manipulation, locomotion).

Every MSR student is expected to be knowledgeable about these core areas. It is understood, however, that with a 48 unit limit, breadth and depth have to be traded off. In addition, with the diverse backgrounds that students entering the program have, it is also understood that individual students will need to complement their prior training with knowledge and skills in foundational disciplines spanning math, software, and hardware.

To accommodate these points, the core requirements are as follows:

- Students must pass coursework worth 12 units in a Foundations area, providing essential prerequisites for mastering the four core areas.
- Students must pass 36 units worth of coursework in the four core areas of Sensing and Perception, Thinking about Actions, Robot Embodiment, and Environment Interaction. Specifically, students must:
    - take a course from each of the four core areas,
    - pass two full semester courses each worth 12 units from two core areas that they wish to acquire deeper knowledge in, and
    - pass two half-semester mini courses each worth 6 units from the remaining two core areas

The mini courses are designed to help students appreciate the broader value and research opportunities of the respective core area, equip them with the basic knowledge and practical skills to enter the area with further self-study, and provide them with sufficient competency to collaborate with an area expert.

- Students can replace each mini course with a full semester course in the same core area with the understanding that their course load in the core areas then increases beyond the required 36 units.

Courses that count toward satisfying the core requirements are:

Foundations Area

16-706: Foundations of Linear Algebra (6 units)

16-707: Foundations of Optimization (6 units)

16-708: Foundations of Statistics (6 units)

16-709: Foundations of Software (6 units)

16-710: Foundations of Manufacturing (6 units)

Sensing and Perception Core Area

16-720: Computer Vision (12 units)

16-722: Sensing and Sensors (12 units)

16-820: Advanced Computer Vision (12 units)

16-822: Geometry-based Methods in Vision (12 units)

16-823: Physics-based Methods in Vision (12 units)

16-833: Robot Localization and Mapping (12 units)

16-705: Fundamentals of Computer Vision Mini (6 units)

15-663: Computational Photography (12 units)

Robot Embodiment Core Area

16-778: Mechatronic Design (12 units)

16-878: Advanced Mechatronic Design for Robotics (12 units)

16-880: Engineering Haptic Interfaces (12 units)

16-704: Fundamentals of Mechatronics Design for Robotics (6 units)

Thinking about Actions Core Area

16-711: Kinematics, Dynamic Systems and Control (12 units)

16-714: Advanced Control (12 units)

16-745: Dynamic Optimization (12 units)

16-782: Planning and Decision Making (12 units)

16-831: Introduction to Robot Learning (12 units)

10-701: Machine Learning (12 units)

10-715: Advanced Machine Learning (12 units)

15-780: Graduate Artificial Intelligence (12 units)

16-702: Fundamentals of Learning Mini (6 units)

16-703: Fundamentals of Control Mini (6 units)

Environment Interaction Core Area

16-741: Mechanics of Manipulation (12 units)

16-761: Mobile Robots (12 units)

16-867: Human Robot Interaction (12 units)

16-700: Fundamentals of Manipulation Mini (6 units)

16-701: Fundamentals of Human Robot Interaction Mini (6 units)

1.3 Elective Courses

The student must take a minimum of 36 elective units, comprising at least three 12 unit courses or by substituting two 6 unit mini's for one of the 12 unit courses. Elective courses can be drawn from appropriate graduate courses in Robotics and in related disciplines at Carnegie Mellon

Robotics Institute graduate level (16-600 and higher) challenge courses require approval. Seminar courses are valuable educational experiences but do not count towards MSR degree requirements. The remaining Robotics Institute graduate level 12-unit courses are pre-approved electives for the MSR program. Elective coursework outside of the Robotics Institute must be approved by the MSR's program chair by the 10th day of the semester in which the elective course is being taken. Request approval by emailing the program chair and the MSR Program Manager.

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1.4 Research Requirements

Supervised research is conducted under the supervision of a Robotics Institute faculty member. (This person may also be referred to as the research advisor or faculty advisor throughout this document). Supervised research consists of working on one of the research advisor's ongoing projects to develop a research thesis question, conduct the research, and create the material results that can give form to the MSR thesis. Supervised research is graded satisfactory/ unsatisfactory, based on the advisor's assessment that the student has learned how to contribute to an original research project.

MSR students are expected to be registered full-time (36 units) during each of their fall and spring semesters. This includes 12 units of 16-997. Students can register for a maximum of 24 units of research (16-997) during the summer terms. The student's final semester may include full time enrollment of research units (16-997), regardless of the semester, fall, spring or summer. A faculty research advisor may require an MSR student to remain on campus and continue full-time research during both summer sessions. Students who receive research assistantships (in the form of tuition or stipend) are expected to satisfy their supervised research requirement by working specifically on the project from which they receive their funding.

Research funding options

Research assistantships (RAs) are awarded to MSR students by research advisors based on availability and student performance. RA positions are provided by faculty projects which are funded by government agencies, private industries, and consortia. Students must be enrolled full time, 36 units, to be eligible for a RA position. RAs will be expected to conduct appropriate research under the direction and guidance of their research advisor.

RA positions are renewable on a semester or academic year basis. RA positions consider the student's performance in course work, as well as the faculty's availability of funds. If support is through an external grant or contract, and this funding is lost, reduced, or changed, the advisor will notify the student accordingly. If a student receives an "N" grade for 16-997 they are ineligible for funding the following semester. Health insurance and academic fees are always the responsibility of the MSR student.

1.5 Internship Option

Practicum (16-990) is a summer only course designed to provide MSR students with an opportunity for an internship experience to count towards the required 84 units of research. MSR students have the option to register for a maximum of 12 units in the summer after their first academic year. Students are not eligible for summer internship credit during the academic year (fall and spring semesters) or in their first or last semester.

MSR students must have their research advisor complete the MSR Summer Internship approval form and submit it to the MSR Program Chair prior to the start of the summer term for final approval. The MSR Program Chair has the final approval for all internships. The research advisor must confirm the content of the internship contributes directly to the student's thesis research project in a way unattainable via standard methods. By providing their approval, the research advisor is committing to oversee the content of the internship, which culminates in a one-page report due to the Program Chair and Program Manager the day before summer grades are due.

16-990 does not incur tuition fees for MSR students. Students may not be enrolled in Practicum in addition to any other CMU course.

International students are required to consult with the Office of International Education for eligibility before seeking an internship/co-op or signing an offer contract (required addition to ensure the university is following immigration laws for F & J status students).

1.6 Thesis Requirement

MS Thesis Committee

The student must form a master's committee by the end of their second semester, consisting of their research advisor(s), an additional RI faculty member, and a senior RI PhD student. If the student is co- advised, both research advisors must be on the committee in addition to another faculty member. The additional faculty member must be from Carnegie Mellon University and should be from a different research group or project than that of the student. The PhD student must have completed their second year of study or have successfully graduated from the Robotics Research Master's program. Replacement of a committee member or addition of a committee member may occur if the incoming committee member confirms in writing their consent to join the committee. Changes to the MS committee cannot occur after the scheduling of the MSR student's thesis talk.

The student is expected to hold at least two research meetings with each member of the committee individually, discussing their research directions. Online forms are used (Speaking and Writing Qualifier forms, via the GS Audit site) by the committee members

to report on and to approve the final thesis document and presentation. Committee approvals must be submitted via the speaking and writing qualifier forms before the grade deadline in the semester which the student wishes to graduate. Any failure of the student to secure all necessary forms may result in the need for an additional semester in the program in order to graduate.

Thesis Talk

The student is expected to give an oral thesis presentation (in person) during standard working hours in a public venue at Carnegie Mellon. The student is expected to demonstrate the ability to present technical material to a technical audience that is not presumed to have specific expertise in the research area. The Master's Committee must be in-person for the duration of the talk. With prior approval by the MSR Program Chair, committee members may designate proxies to evaluate the presentation and fill out the Oral qualifying form.

The student must advertise their thesis talk to the RI community email distribution list a week in advance and send a reminder a day in advance of their talk. Failure to advertise as dictated above will result in the student rescheduling their thesis talk to allow for proper policy adherence. This may postpone their graduation semester. The oral thesis presentation must occur on a weekday on or before the last day of classes in the semester the student intends to graduate. See “Unsuccessful Thesis” section for further implications.

Thesis Document

The student is also expected to deliver a master’s thesis describing the supervised research. This should be a document for which the student is the sole or principal author. The thesis should demonstrate a style, organization, and clarity that enables researchers in the field to comprehend the problem, method, and results of the research.

The thesis must, at a minimum, contain the following sections and content: Background, Research Question, Related Work, Methods, Results, and Conclusions. There is not a specific page-based minimum length for the thesis document. Once approved, the thesis must be archived as a Carnegie Mellon Technical Report. The principal approval for the thesis document is provided by the student's committee, via the Writing Qualifier form.

The student is also expected to deliver a complete thesis draft document to every member of their committee and to the MSR program leadership two weeks (minimum of 10 business days) in advance of the oral presentation.

Failure to send a completed thesis draft to the MSR Program Chair, MSR Program

Manager, and the entire thesis committee, as outlined above. will result in the student rescheduling their thesis talk to allow for proper policy adherence. This may impact the student's graduation semester. See "Unsuccessful Thesis" section for further implications.

Research / Thesis Expectation and Successful Completion Requirements

In both the presentation and document, the student should convey a mastery of a topic related to contemporary robotics research. The student should present a summary of work related to the topic from the current research literature and should clearly describe how their research fits into the context of that research. It is not necessary for the student to generate their own novel research results that go beyond the current state of art, but, of course, novel results are welcome and will strengthen the presentation and document.

All thesis requirements, including upload and qualifier forms, must be received by the date and time that grades are due for certification in that semester.

Missing qualifier forms or failure to upload the thesis as outlined above will result in the student rescheduling their thesis talk to allow for proper policy adherence. This may impact the student's graduation semester. See "Unsuccessful Thesis" section for further implications.

Unsuccessful Thesis (Written and/or Oral)

If the MS Committee does not indicate the student passed their written or oral thesis requirements, via the completion (or failure of submission) of the MSR speaking and writing qualifier forms, the student will not graduate that semester. The MSR student must register for a minimum of 5 units of 16-997 in the semester they wish to graduate, which must fall within the MS Student statute of limitations. The thesis talk and document process must be followed again in the semester that the student wishes to graduate. Multiple attempts in the same semester are allowable. There is no limit to the number of attempts an MSR student can make provided they are within the statute of limitations for the degree.

1.7 Standard schedule for degree completion

First year of MSR Program

Fall	Units	Spring	Units
Core Course	12 units	Core Course	12 units
Core Course	12 units	Core Course	12 units
Reading and Research – 16-997	12 units	Reading and Research – 16-997	12 units
	36 units		36 units

Summer One

Reading and Research 16-997: 24 units

Second Year of MSR Program

Fall	Units	Spring	Units
Elective Course	12 units	Elective Course	12 units
Elective Course	12 units	Reading and Research – 16-997	24 units
Reading and Research – 16-997	12 units		36 units
	36 units		

Summer Two

Reading and Research 16-997 - 12-36 units / Complete thesis and graduation requirements.

1.8 Requirements for entry into Ph.D. program

MSR students are eligible to apply for the Robotics Institute PhD program in the same way all other PhD applicants are reviewed.

1.9 Advising

MSR Students must notify (via email with faculty research advisor included) the MSR Program Chair and Program Manager of their mutually agreed-upon advisor-advisee relationship with a chosen faculty member.

Advisor Selection Deadlines:

Fall Semester start - you must have a faculty advisor by October 31st

Spring Semester start - you must have a faculty advisor by April 15th

1. MSR Program Chair Prof George Kantor
2. MSR Program Manager Angelica Bondy
3. Research Advisor(s): The MSR research faculty member must have a faculty appointment with RI. Any faculty member accepting the master's advisor relationship is never financially responsible for the master's student, except in the relatively rare cases when a research assistantship has been explicitly negotiated. You and your advisor will mutually agree upon meeting frequency, meeting purpose, required meeting preparation and any other guidelines necessary to ensure a successful relationship.

Grading and Evaluation

1.10 MSR Policy on Grades for Retaking a Course

The MSR program only factors the seven courses that are counting towards the MSR degree into the MSR QPA. Any additional coursework or repeated coursework will not be counted in the final MSR QPA but will still be present on the student's transcript and calculated in the overall CMU QPA Courses taken while not enrolled as a degree seeking MSR student will not be factored into the student's overall CMU QPA.

1.11 Independent Study/Directed Reading

Independent Study (16-995) is a course designed to provide students with an opportunity

for intensive study of a subject that is either unavailable or insufficiently covered in regular course work or cannot be obtained during the standard MSR Reading and Research units. Independent study is not intended to substitute for existing courses, but to provide the opportunity for specialized educational and research experience.

Any faculty member in the Robotics Institute is eligible to serve as the supervisor of an Independent Study project. The student must complete the Independent Study Request form, which includes a brief prospectus of the project to the faculty supervisor as a basis for reaching agreement on the objectives of the study. The Independent Study Request Form will be reviewed by the MSR Program Chair for final approval. Independent studies may only be requested during the course add period for any given semester.

1.12 GPA Requirements and QPA Requirements for Graduation

All courses counting towards the MS in Robotics degree must be passed with a grade of B- or better. 84 units of 16-997 (include 16-990 if applicable) must be passed with a grade of satisfactory.

1.13 Regular Reviews and Evaluations by Department

Satisfactory progress in coursework will be assessed by the student keeping up with the course schedule and passing courses. The faculty research advisor will assign a satisfactory/ unsatisfactory grade every semester for the supervised research.

Review of students' grades will take place at the conclusion of each semester by the MSR Program Chair and MSR Program Manager. Academic actions will be provided to those impacted prior to the start of the next academic semester.

Satisfactory progress in the MSR program is defined as a student passing one or two academic courses with a grade of a B- or better and receiving a satisfactory review from their research advisor for 16-997. If the student has completed all academic courses, satisfactory progress is a satisfactory review from their research advisor for a minimum of 36 units of 16-997.