



## ROBOTICS GRADUATE PROGRAM MANUAL

[robotics.umich.edu](http://robotics.umich.edu)

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## 1. INTRODUCTION

Michigan Robotics offers Master's and Ph.D. degrees. Both programs are built on a common set of course requirements, with Ph.D. students also completing research published in leading journals in the field of robotics.

The Michigan Robotics program consists of three main technical areas, which converge as students produce functioning robots:

- Sensing of the environment, external agents, and internal body information to determine state information
- Acting upon the body and environment to produce motion or other outputs that enable the robot to locomote or interact with the environment
- Reasoning with that information to make decisions for guidance, control, and localization

Our students come to the field with a variety of backgrounds, particularly in mechanical engineering, electrical engineering, and computer science. They learn to work in teams to accomplish the many tasks necessary to build and operate an autonomous system, including mechanical design, electronics, programming and integrating all the parts. Students graduate the program as independent researchers and engineers, and many will go on to become leaders in robotics research, in academia, industry and government.

## 2. ADMISSION

Admission to the Robotics Graduate programs is through the Rackham Graduate School. Information regarding applying can be found on [Rackham's website](#).

It is the responsibility of the applicant to make sure the Robotics Graduate Program receives the completed application form and all additional required materials by the specified deadlines.

An engineering background is recommended but not required for the Robotics Program, although we have found that the lack of an engineering background puts students at a disadvantage as they begin their graduate studies. In general, our Admissions Committee is most interested in undergraduate and graduate academic performance, GRE scores, research experience, letters of recommendation (with particular attention to letters coming from faculty in relevant fields) and the academic statement of purpose.

Ph.D. students admitted without a master's degree may complete the master's requirements as they progress through the Ph.D. Program.

Current U-M graduate students in other programs may be eligible to earn a dual degree in Robotics. Beginning August 2019 the Robotics Graduate Committee will no longer accept dual degree

applications from students whose primary program offers a Robotics option (e.g. ECE: Robotics, MECHENG: Mechatronics) unless an exceptional situation exists. The Graduate Committee will review all application-centered credentials. Minimum requirements are >3.5 cumulative Rackham GPA and B+ or better grades in ROB 501 and ROB 550.

### **3. GENERAL ACADEMIC POLICIES**

#### **Cognate Course Requirement**

The Rackham Graduate School requires Ph.D. students and Master's students admitted prior to Fall 2018 to complete coursework outside of their major research/interest area. Master's students admitted Fall 2018 or later are not required to fulfill the cognate requirement. Should a Master's degree student continue into the Ph.D. program the 3-credit\* cognate requirement will need to be fulfilled. Only letter graded graduate level courses may be used to meet this cognate requirement.

Any graduate level course outside of the Robotics Institute meets this requirement. Also, cross-listed courses within the Robotics Institute are allowed; however, a course cannot count toward the cognate requirement if it was also used to fulfill the depth or breadth requirement, and the cognate course must be outside the student's depth area. For example: If a student's depth area is Sensing, a Sensing course cannot count toward the cognate requirement.

\*The cognate requirement was 4 credits for students who advanced to candidacy before Fall 2020.

#### **Course Withdrawal**

Courses dropped after the 3rd week registration period will receive a "W" on transcript.

After the eighth week of a full term (fourth week of a half term), courses may be dropped until the last day of the term or changed to Visit/Audit status only under exceptional circumstances and with the approval of the course instructor, and advisor.

Courses elected as Visit/Audit cannot count toward degree requirements.

You cannot remove courses from your transcript.

Term specific deadline dates are posted on the [Registrar's Office website](#).

#### **Dual Degree and Certificate Programs**

Robotics students have the ability to obtain master's degrees or graduate certificates in other programs at U-M. Adding a master's degree or graduate certificate may require additional coursework and semesters to a student's time at U-M. In addition, there is a limit to how many courses can be counted towards the original master's degree and the added master's degree or

graduate certificate. Adding a graduate certificate can only be done if the student is currently enrolled in a Master's or Ph.D. program.

Students interested in pursuing this option must contact the graduate program of interest to find out the requirements to add the degree.

## **English Proficiency**

Based on English language proficiency test scores (such as the TOEFL), some students will be encouraged by the Rackham Graduate School to take specific academic writing or speaking courses offered by the English Language Institute (ELI) to support their studies. The ELI courses are typically 1 to 3 credits, and will help students gain capability and confidence in English. These courses will not count toward the degree or GPA.

A student's English proficiency is also evaluated as the Ph.D. student participates in the oral Qualifying Exams and Research Thesis Proposal presentation. If the faculty considers the student to otherwise be qualified for the Robotics Ph.D. program, it may be recommended that the student take English courses. Students with major deficiencies in English will be found Not Qualified for the Robotics Ph.D. Program.

## **Enrollment Status**

Regarding courses:

Full time enrollment is 8 credit hours.

For GSI/GSRA, full time enrollment is 6 credit hours.

ELI courses do count towards enrollment status.

Visit/Audit of a class does not count towards enrollment status.

Ph.D. students are required to register every Fall and Winter term unless on an approved Leave of Absence. Learn more about Rackham's Continuous Enrollment policy [here](#).

Regarding tuition:

For 1-8 credits, a master's and pre-candidate student's account is charged an amount for each credit hour.

For 9+ credits, a master's and pre-candidate student's account is charged a single amount for all the credits.

Candidates are charged at the Candidacy tuition rate as they will register for 8 hours of 995 each Fall and Winter term (and Spring/Summer full term if defending and/or completing the doctoral degree requirements during Spring/Summer term).

## Grades and GPA Requirement

All grades are on the Rackham Graduate School scale:

A+	4.3	B+	3.3	C+	2.3	D+	1.3
A	4.0	B	3.0	C	2.0	D	1.0
A-	3.7	B-	2.7	C-	1.7	D-	0.7

Course grade must be B- or better for the credit hours to be counted toward any MS degree requirement.

The grade point average (GPA) must be at least 3.0, based on Rackham's 4.0 scale. A cumulative GPA below a 3.0 will cause the student to lose "satisfactory academic standing".

A student must have a minimum cumulative Rackham GPA of 3.0 (B) to be granted a degree.

## Graduation

Graduation for the Master's or Ph.D. degree is not automatic. A student who has fulfilled all degree requirements must apply for graduation in the term in which completion is expected and will be prohibited from further enrollment.

The last day to apply for graduation for the current semester is the last day of classes (not the final exam period).

## Honor Code

All engineering programs at the University of Michigan follow the [College of Engineering Honor Code](#) outlining certain standards of ethical conduct. The Honor Council investigates reported violations of the Honor Code.

## International Students

### Curricular Practical Training (CPT) for F-1 Students

The intent of CPT is for students to engage in practical job experience that directly relates to their academic program of study. Students must choose their internships carefully with the

understanding that any job that is NOT specifically related to the applicant's major area of study, will likely result in the denial of the CPT request.

Students who would like to enroll in CPT should go to the [Robotics website](#) for instructions.

Credit for CPT (Rackham 998) may not be counted toward any ROB degree requirements.

#### Optional Practical Training (OPT) for F-1 Students

OPT is defined in the Federal Regulations as temporary employment directly related to a student's field of study. During OPT, a student remains in F-1 status. The end result of the OPT request process is an Employment Authorization Document (EAD) issued by United States Citizenship and Immigrations Services (USCIS).

Processing OPT applications typically requires 60 to 90 days.

Some STEM students may be eligible for a 17 month extension of OPT.

Students who would like to enroll in OPT should go to the [Robotics website](#) for instructions.

#### Reduced Course Load (RCL) for F-1 Students

International students, who drop below full time status or who need fewer than 8 credits to complete their program requirements, may apply for RCL through the International Center.

Please note that students are eligible for RCL only if they have not yet completed their degree requirements. Due to Federal regulations, students must apply for their degree in the semester in which they complete their degree requirements. If a student wants to remain in the country after completing their requirements, they must apply for OPT.

Students who would like a RCL should go to the [Robotics website](#) for instructions.

## 4. MASTER'S DEGREE REQUIREMENTS

To receive a Robotics MS degree, a student must satisfy the Robotics Graduate Program requirements outlined below as well as the Rackham School of Graduate Studies General Master's Degree Requirements as stated in the Rackham Graduate School Academic Policies and the College of Engineering Regulations as specified in the College of Engineering Bulletin.

### Master's Degree Credit Distribution/Coursework

The Master's degree requires a minimum of 30 graduate level credit hours with the following distribution:

- 7 credits for ROB 550 (4 credits) & ROB 501 (3 credits)
- > 12 credits of technical graded courses
  - Breadth requirement: > 9 credits (at least 1 course from each of the 3 core areas: sensing, acting, reasoning)
  - Depth requirement: > 3 credits in "depth area" (at least 1 additional course taken from at least one of the 3 core areas: sensing, acting, reasoning)
- > 4 credits of graded cognate coursework (only required for students starting prior to Fall 2018). Cognate course(s) cannot be in "depth area"
- < 6 credits of Directed Study (ROB 590)
- 3 credits of Advanced Research (ROB 690) - Optional
- 3 credits of ROB 502 "Programming for Robotics" - Optional

Sample Schedule for a student taking ROB 502 Term 1:

Term 1: 7-10 credits\*

- ROB 502
- ROB 501
- ROB 590, Sensing course, Acting course, Reasoning course, or Elective

Term 2: 7-10 credits\*

- ROB 550
- ROB 590, Sensing course, Acting course, Reasoning course, or Elective
- Sensing course, Acting course, Reasoning course, or Elective

Term 3: 7-10 credits\*

- Sensing course, Acting course, Reasoning course, or Elective
- Sensing course, Acting course, Reasoning course, or Elective
- Sensing course, Acting course, Reasoning course, or Elective

Term 4: If necessary: any remaining requirements



## Sample Schedule for a student taking ROB 550 Term 1:

### Term 1: 7-10 credits\*

- ROB 550
- ROB 501
- ROB 590, Sensing course, Acting course, Reasoning course, or Elective

### Term 2: 7-10 credits\*

- ROB 590, Sensing course, Acting course, Reasoning course, or Elective
- Sensing course, Acting course, Reasoning course, or Elective
- Sensing course, Acting course, Reasoning course, or Elective

### Term 3: 7-10 credits\*

- ROB 690, Sensing course, Acting course, Reasoning course, or Elective
- Sensing course, Acting course, Reasoning course, or Elective
- Sensing course, Acting course, Reasoning course, or Elective

### Term 4: If necessary: any remaining requirements

\*Per section 2.1 of the Rackham Academic Policies: “Some graduate programs, other University policies, or U.S. government agencies, such as the Veterans Administration and the U.S. Citizenship and Immigration Services, may require a student to be enrolled for a minimum number of credit hours to be considered a full-time student. International students must be enrolled full-time under requirements set by the U.S. Citizenship and Immigration Services, and on F-1 or J-1 visas should consult the [International Center](#) with any questions concerning enrollment, course registration, and visa status. International students who wish to be registered less than full-time must obtain permission in advance from the International Center or risk compromising their visa status.

All course requirements must be letter-graded (A, B, etc.) and may not be marked as satisfactory/unsatisfactory except for the directed study requirements.

Courses that do not count towards master’s degree requirements:

- Courses with number 990, 995 or other course with “doctoral,” “dissertation,” or “preliminary” in the title may not be counted towards master’s degree requirements.
- Rackham 998 (Curricular Practical Training) may not be counted for any degree requirements.
- ELI courses can be counted toward degree requirements on a case by case basis.
- Courses with insufficiently advanced content and level, or which substantially duplicate in content and level courses already completed by the student.

## **ROB 590 Directed Study**

A minimum of 3 credits (and a maximum of 6 credits) of ROB 590 is required to fulfill the Robotics MS degree requirements. A ROB 590 directed study project is research supervised by a robotics faculty member (core or affiliate) and the directed study project requirements are up to each individual faculty advisor.

At this time, the Robotics Grad Office does not have a list of faculty who are looking for students to work on a project. It is up to each student to seek out faculty with whom they are interested in working.

If you are seeking ROB 590 credit for MDP, approval is required from the grad committee: please email [um-robotics@umich.edu](mailto:um-robotics@umich.edu).

## **ROB 690 Master's Advanced Research**

ROB 690 is faculty-supervised research that culminates in a submitted and graded document. The expectation is that the student will write and submit an original conference style paper based on their advanced research that builds on earlier research completed in three to six credits of ROB 590. Specific expectations are determined determined by the research advisor. ROB 690 will be letter graded (not S/U).

Registration will require an email from the advisor to [um-robotics@umich.edu](mailto:um-robotics@umich.edu) approving the registration, as well as an electronic permission from the grad office.

There are 2 different registration options for ROB 690:

### **Option 1:**

**Term X:** register for 3 credits of ROB 590

**Term Y:** register for 3 credits of ROB 590 AND 3 credits of ROB 690

### **Option 2:**

**Term X:** 3 credits of ROB 590

**Term Y:** 3 credits of ROB 590

**Term Z:** 3 credits of ROB 690

## MS Degree Worksheet

The MS Degree Worksheet is a form that maps out which courses satisfy the specific degree requirements. Effective with the Fall 2018 incoming class it is required that students submit to [um-robotics@umich.edu](mailto:um-robotics@umich.edu) a plan of study, approved and signed by their corresponding Faculty Advisor, by the end of October of their first term and by the end of January or September in the term in which they apply for graduation. All admitted MS students (with the exception of Ph.D. students and dual degree students) will be assigned a Faculty Advisor. All other students must submit their MS Degree Worksheet in the term in which they apply for graduation. Failing to do so will risk the student's ability to graduate.

Please Note: It is the responsibility of the student to submit to the Robotics Graduate Program Coordinator ([um-robotics@umich.edu](mailto:um-robotics@umich.edu)) an updated, signed final MS Degree Worksheet. Failure to submit this Worksheet timely could delay graduation.

## Master's Degree Timeline

The timeline below displays a "typical" Master's student progress in our program in 3 or 4 semesters. Students must complete all work for the Master's degree within five years from the date of first enrollment in the program. Those exceeding this limit must petition Rackham for a time extension or be withdrawn from the program.

Academic Term	Coursework	Research Activities (optional)	Milestones
Year 1: Fall	8-9 credits	Search for a research advisor	>3.0 GPA
Year 1: Winter	8-10 credits	Choose a research advisor for independent study	>3.0 GPA
Year 1: Sp/Su		Independent study or Internship	
Year 2: Fall	8-11 credits	Independent study	>3.0 GPA; (Apply for graduation)
Year 2: Winter	3-6 credits	Independent study	>3.0 GPA; (Apply for graduation)

## **Transfer of Credit**

Students who want to transfer credits must follow the Rackham Transfer of Credit guidelines:

- A student is eligible to transfer up to 6 credits from external institutions or 15 credits can be transferred from within the University of Michigan.
- Credits can only be transferred to the MS program
- These credits must be used in whole and cannot be split (e.g. only use 2 of the 4 credits).

To transfer credits:

- Student must complete 8 credits of graded graduate courses at the University of Michigan to transfer credits.
- Student must have a minimum cumulative Rackham GPA of 3.0.

Transfer credits must meet the following criteria:

- Be a graduate level course
- Receive a “B” grade or higher
- Cannot have been used to satisfy degree requirements for undergraduate or graduate degree. (In other words, they must be extra credits taken)

## **Applying to Ph.D. Program**

Current MS students interested in the Robotics Ph.D. program must apply by following the Rackham application process. Applications for the PhD program must be accompanied by a (confidential) letter of support from the student’s anticipated research advisor that endorses the application, describes the time frame of the student’s directed research activities, and expresses an intent to mentor and financially support the student if s/he is admitted to the PhD Program.

## **Advisor/Co-Advisor**

All Ph.D. students are admitted with at least one primary advisor who must be Core Robotics Faculty. Ph.D. students who enter on fellowship are required to add a co-advisor (can be Core or Affiliate Robotics Faculty) by the end of their second term in the program. GSRA students may add a co-advisor but are not required to. The co-advisor does not have to have a significant role in the student’s research but meetings should occur at least once per term.

## 5. PH.D. DEGREE REQUIREMENTS

### Relevant Master's Degree

If a student entering the Ph.D. Program already has a master's degree, it may be determined at the time of admission that the master's degree coursework is sufficiently similar to the Robotics Master's degree requirements/coursework. If so, the coursework is deemed to be relevant. If a student believes their master's degree to be relevant please email the Graduate Coordinator ([um-robotics@umich.edu](mailto:um-robotics@umich.edu)) a copy of the transcript along with an explanation of why the degree should be considered relevant.

### Embedded Master's Degree

Students who enter the Ph.D. Program without a relevant master's degree are not automatically enrolled in the Robotics Master's Program. To add the Master's degree, students need to submit a final MS Degree Worksheet to the Robotics Graduate Coordinator at the beginning of the semester in which the student will complete the master's degree requirements. The Graduate Coordinator will request that the Registrar's Office add the MS program to the student's record. The student is then required to apply for graduation via the Wolverine Access system.

### Ph.D. Degree Credit Distribution/Coursework

1) *Without a relevant Master's degree*, a student must complete a minimum of 36 graduate level credit hours with the following distribution:

- 7 credits for ROB 550 (4 credits) & ROB 501 (3 credits)
- > 12 credits of technical graded courses
  - Breadth requirement: > 9 credits (at least 1 course from each of the 3 core areas: sensing, acting, reasoning)
  - Depth requirement: > 3 credits in "depth area" (at least 1 additional course taken from at least one of the 3 core areas: sensing, acting, reasoning)
- > 3 credits\* of graded cognate coursework. Cognate course(s) cannot be in "depth area". \*The cognate requirement was 4 credits for students who advanced to candidacy before Fall 2020.
- < 6 credits of Directed Study (ROB 590)

2) *With a relevant Master's degree*, a student must complete a minimum of 18 graduate level credit hours with the following distribution:

- 7 credits for ROB 550 (4 credits) & ROB 501 (3 credits)
- > 12 credits of technical graded courses unless course equivalency has been granted
  - Breadth requirement: > 9 credits (at least 1 course from each of the 3 core areas: sensing, acting, reasoning)
  - Depth requirement: > 3 credits in “depth area” (at least 1 additional course taken from at least one of the 3 core areas: sensing, acting, reasoning)
- > 3 credits\* of graded cognate coursework. Cognate course(s) cannot be in “depth area”. \*The cognate requirement was 4 credits for students who advanced to candidacy before Fall 2020.
- < 6 credits of Directed Study (ROB 590)

Note:

- There is no additional “core area” requirement here for the extra 6 credits -- just advisor approval.
- Technical courses are generally courses from Engineering, Math, Statistics, Physics, and other science disciplines. The academic advisor must approve courses from Economics, Business, etc.

Courses that do not count towards Ph.D. degree requirements:

- Courses with number 990, 995 or other course with “doctoral,” “dissertation,” or “preliminary” in the title may not be counted towards master’s degree requirements.
- Rack 998 (Curricular Practical Training) may not be counted for any degree requirements.
- ELI courses can be counted toward degree requirements on a case by case basis.
- Courses with insufficiently advanced content and level, or which substantially duplicate in content and level courses already completed by the student.

You must maintain a cumulative 3.5 GPA (on a 4.0 scale, A=4.0) and must make a grade of B+ or higher in all courses counted toward your robotics Ph.D.

A cumulative GPA lower than 3.5 could potentially result in the student being placed on academic probation.

## Course Equivalency

If a student has taken a course elsewhere that is “substantially equivalent” to a Robotics course/requirement, it may not be necessary to retake the course/requirement. The student should consult with their academic and/or research advisor at the earliest opportunity to determine whether or not

equivalency is appropriate. An equivalent course cannot count toward the required 18 credits to advance to candidacy.

Students entering with a Master's degree must submit a review request by email to the Graduate Coordinator and Graduate Chair as part of the planning and advising process at the beginning of their first term in the graduate program. For course equivalency approval, additional supporting documentation is required such as a syllabus, course description, homework, etc. Please email supporting documentation to [um-robotics@umich.edu](mailto:um-robotics@umich.edu).

## **Annual Progress Report/Financial Support**

Continued enrollment and guaranteed financial support is contingent upon satisfactory academic and research progress by the student.

Student evaluations are conducted annually at the end of the winter semester with a due date of May 31st. As of May 2019 the Annual Progress Report is an online process. The student and his/her research advisor will complete and electronically sign the Annual Progress Report.

This report will identify one of three possible outcomes:

- Satisfactory
- Concerns
- Unsatisfactory

Submission of the annual report is mandatory. Failure to submit the Annual Progress Report may lead to a rating of 'Unsatisfactory'. Lack of satisfactory progress may lead to the termination of the guarantee of financial support and to the student's discontinuation from the graduate program.

When a student's progress is deemed to be of 'Concerns' or 'Unsatisfactory', an interim Progress Report will have to be submitted. At these times, the student's overall progress will be re-evaluated. The Graduate Program Chair may also request submission of an interim Progress Report prior to the April annual evaluation. Research progress deemed of concern or unsatisfactory could potentially result in the student being placed on academic probation.

A student with guaranteed financial support will be told in writing at least two months before his/her tuition, stipend and health insurance actually ends. If the stipend is terminated during a term in which the student is enrolled, financial obligations (tuition & fees, stipend, and health insurance) will be covered until the end of the term.

## **Leave of Absence**

Per section 2.2.2 of the Rackham Academic Policies "A leave of absence enables a doctoral student to not register during a fall or winter term and remain in compliance with the continuous enrollment requirement. A leave will be granted to students recovering from illness or injury, who are providing

care or assistance for family and dependents, who are meeting military service obligations, or for other personal reasons. Learn more about Rackham’s Leave of Absence policy [here](#).

## Academic Probation

If a student demonstrates poor research performance or insufficient progress in either the coursework-based or research-based qualifying exam, Robotics will potentially place the student on probation, following section 3.5.2 of the Rackham Academic Policies to do so. Learn more about this policy [here](#) or in this manual’s [Appendix](#).

## Ph.D. Degree Deadlines

Number of full semesters (Fall & Winter) after entry by which milestone should be completed		
Milestone	Enter without relevant Master’s	Enter with relevant Master’s
Master's degree coursework	4	N/A
Ph.D. degree coursework	6	3
Qualification Exams	5	4
Candidacy	5	4
Thesis Proposal	6	5
Thesis Defense	9 - 12	7 - 10

A student may be given 4 additional months/1 term to complete each milestone with approval from their Research Advisor(s) and the Graduate Program Chair.

Students must complete any remaining credits after achieving Candidacy and prior to giving their Thesis Proposal.

## Ph.D. Degree Timeline

The Rackham Graduate School allows up to 7 years from the first term of enrollment. Students who do not complete the Ph.D. degree in 7 years must submit a petition to Rackham requesting an extension. Though Rackham policy allows for 7 years, the Robotics Institute expects the majority of students to complete the Ph.D. degree in no more than five years. Financial support is guaranteed for 5 years (or 4 years for students entering with a relevant master’s). Students who take longer than four (if entering with a relevant master’s) or five years to complete the Ph.D. degree may lose departmental financial support. Funding beyond this point must be worked out between the student and advisor. The Ph.D. is unique to each student due to the nature of research and is subject to greater flexibility in timing.



Below is the typical timeline for the Ph.D. student entering *without* a relevant master's degree:

Academic Term	Coursework	Research Activities	Milestones
Year 1: Fall (Term 1)	2-3 courses	Departmental and area research seminars, Faculty/student research meetings	≥3.5 GPA
Year 1: Winter (Term 2)	2-3 courses  Prepare for Qualifying Exam #1	Departmental and area research seminars, Faculty/student research meetings	≥3.5 GPA  Complete Qualifying Exam Part 1 (or wait until term 3)
Year 1: Sp/Su			Identify a topic for Qual research project.  Begin preliminary readings and a preliminary problem statement
Year 2: Fall (Term 3)	2-3 courses  Directed research  Prepare for Qualifying Exam #1 or #2	Faculty/student research meetings in area of interest, directed research with research advisor	≥3.5 GPA  Refine the problem statement  Begin research  Complete Qualifying Exam Part 1 or Part 2
Year 2: Winter (Term 4)	2-3 courses  Prepare for Qualifying Exam #2		≥3.5 GPA  Complete Qualifying Exam Part 2
Year 2: Sp/Su			Continue/begin research for Thesis Proposal
Year 3: Fall (Term 5)	If not advancing to candidacy, take remaining required courses and prepare for Qualifying Exam #2  If advancing to candidacy, ROB 995 + optional addtl course(s)*	Research with research advisor, faculty/student research meetings in other areas of interest	Advance to candidacy if requirements (including coursework and both quals) have been completed. If not, Complete Qualifying Exam Part 2

Year 3: Winter (Term 6)	ROB 995 + optional addtl course(s)*	Research with research advisor, faculty/student research meetings in other areas of interest	Advance to candidacy if requirements (including coursework and both quals) have been completed.
Year 3: Sp/Su		Ph.D. research	
Year 4: Fall (Term 7)	ROB 995 + optional addtl course(s)*	Ph.D. research	Problem formulation, preliminary readings and derivations for Ph.D. Thesis Proposal
Year 4: Winter (Term 8)	ROB 995 + optional addtl course(s)*	Ph.D. research	Problem statement, refinement, form dissertation committee and present a Thesis Proposal
Year 4: Sp/Su		Ph.D. research	
Year 5: Fall (Term 9)	ROB 995 + optional addtl course(s)*	Ph.D. research	Update dissertation committee on research progress
Year 5: Winter (Term 10)	ROB 995 + optional addtl course(s)*	Ph.D. research	Final oral defense  Complete any dissertation revisions & graduate with Ph.D.

\*Refer to 'Course Enrollment' in 'Candidacy' below

Below is the typical timeline for the Ph.D. student entering with a relevant master's degree:

Academic Term	Coursework	Research Activities	Milestones
Year 1: Fall (Term 1)	2-3 courses	Departmental and area research seminars, Faculty/student research meetings	≥3.5 GPA
Year 1: Winter (Term 2)	2-3 courses  Prepare for Qualifying Exam #1	Departmental and area research seminars, Faculty/student research meetings	≥3.5 GPA  Complete Qualifying Exam Part 1 (or wait until term 3)
Year 1: Sp/Su			Identify a topic for Qual research project.  Begin preliminary readings and a preliminary problem statement

Year 2: Fall (Term 3)	2-3 courses  Directed research  Prepare for Qualifying Exam #1 or #2	Faculty/student research meetings in area of interest, directed research with research advisor	≥3.5 GPA  Refine the problem statement and begin research  Complete Qualifying Exam Part 1 or Part 2
Year 2: Winter (Term 4)	2-3 courses  Prepare for Qualifying Exam #2		≥3.5 GPA  Complete Qualifying Exam Part 2
Year 2: Sp/Su			Continue/begin research for Thesis Proposal
Year 3: Fall (Term 5)	If not advancing to candidacy, take remaining required courses and prepare for Qualifying Exam #2  If advancing to candidacy, ROB 995 + optional addtl course(s)*	Research with research advisor, faculty/student research meetings in other areas of interest	Advance to candidacy if requirements (including coursework and both quals) have been successfully completed. If not, complete Qualifying Exam Part 2  Problem formulation, preliminary readings and derivations for Ph.D. Thesis Proposal
Year 3: Winter (Term 6)	ROB 995 + optional addtl course(s)*	Research with research advisor, faculty/student research meetings in other areas of interest	Advance to candidacy if requirements (including coursework and both quals) have been successfully completed.  Problem statement, refinement, form dissertation committee and present a Thesis Proposal
Year 3: Sp/Su		Ph.D. research	
Year 4: Fall (Term 7)	ROB 995 + optional addtl course(s)*	Ph.D. research	Update dissertation committee on research progress (at least once during the academic year)
Year 4: Winter (Term 8)	ROB 995 + optional addtl course(s)*	Ph.D. research	Final oral defense  Complete any dissertation revisions & graduate with Ph.D.

\*Refer to 'Course Enrollment' in 'Candidacy' below

## Qualification Examination

A major milestone for Ph.D. students is to pass the qualifying/preliminary exams, which along with required coursework completion advances the student to Ph.D. candidate status. The qualification process is comprised of a review of academic performance, a technical (coursework-based) qualifying exam, and a research-based preliminary exam. A Ph.D. student is considered to have adequate performance in coursework if his/her grade-point average is 3.5 or above. Both components of the exam are typically completed after either three or four semesters in the program. Once required Ph.D. coursework and both preliminary exam components have been successfully completed, a Robotics Ph.D. student is encouraged to apply for Ph.D. candidacy. Specifics and instructions for each exam are provided below.

### Part 1: Technical (Coursework-based) Qualifying Exam

The technical qualifying exam is typically taken by students approaching the end of their second semester in the Robotics Ph.D. program. It is expected that all Robotics students will complete the technical qualifying exam no later than the end of a student's third semester in the Robotics Ph.D. program. Each student is eligible for a maximum of one exam re-take if needed. The qualifying exam is offered twice per year, once in December and once in April/May.

Qualifying exam questions will be based upon content in ROB 501 and ROB 550. The qualifier is an oral exam in which the student is examined by two faculty members from the robotics program. Neither qualifying examination faculty member will be the student's advisor or co-advisor; the examining faculty will be assigned by the graduate committee soon after the student submits a "qualifying exam request" as stipulated below. The faculty committee will examine the student's understanding of technical fundamentals by asking a combination of conceptual and problem-solving questions. The student is expected to share their thoughts as they solve each problem, using the examination room whiteboard to write down pertinent concepts, derivations/calculations, and solutions. It is common for examiners to give "hints" periodically - students are highly encouraged to ask examiners for clarification and listen carefully to guidance. If a concept is not familiar, make sure you share this with the examiner so he/she can explain further. While we expect students to demonstrate robotics problem-solving skills, we do not expect perfect recall of facts. Insufficient progress in either the coursework-based or research-based qualifying exam could potentially result in the student being placed on academic probation.

#### **Coursework-based qualifying exam procedure:**

A student must have selected a primary advisor and a co-advisor (for fellowship students) prior to signing up for the qualifying exam. GSRA students only require a primary advisor. The student is

responsible for securing approval to take the exam from his/her advisor (and co-advisor for fellowship students).

The student must indicate his/her intention to take the qualifying exam upon receiving the qualifying examination instruction email from the grad coordinator mid-semester. In indicating their intention to take the exam they must include:

- Student's advisor
- Student's co-advisor (required for all fellowship students)
- Student's updated unofficial transcript showing courses taken and courses in which the student is currently enrolled.
- One-sentence summary of the student's independent study research area.
- Recommendations of any (up to three) robotics faculty members the student would prefer not serve as examiners.

The graduate committee will assign two examination faculty to each student. The student is expected to coordinate a two-hour exam day/time block with examination committee members. Students should feel free to email their examiners to ask for advice; specifics of this correspondence will be left to the discretion of the examiners. Examiners will be asked to rate the student based on their level of mastery in each course as well as overall ability to think and communicate with the examiners.

Once the exam has been completed, the examiners will return their evaluations to the graduate committee. The graduate committee will present examination results to the robotics faculty who will collectively determine the exam outcome for each student.

## Part 2: Research-based Qualifying or Preliminary Exam

The Research-based (Part 2) Qualifying Exam is typically taken the term after the Coursework-based (Part 1) qualifying exam to test the student's ability to conduct independent research at the Ph.D. level. There are four primary objectives: (1) Assess depth of knowledge in the area of research specialization and the ability to relate this to research, (2) Assess ability to propose an interesting and relevant problem for Ph.D. research, (3) Test ingenuity, creativity, and problem-solving skills, and (4) Assess written and oral communication skills and the ability to respond to questions.

**Format and Timeline:** The research preliminary exam is typically taken the semester after the student successfully completes the technical qualifying exam. Exams are typically held in December (fall) and April/May (winter). The scheduled oral exam lasts for 90 minutes structured as a 30 minute presentation with up to 60 minutes of question and answer by two robotics faculty members. This exam will be scheduled for a 1.5 hour window.

**Registration:** Eligible students must register their intent to take the exam with both the Graduate Program Chair and Graduate Coordinator as an email response to the qualifying exam instructions sent out mid-semester. In this email, the students must submit the following: (1) A bio-sketch using

the NSF Fellowship application format, (2) A research paper title and 150-200 word abstract, (3) A list of courses taken with discussion of how the courses match the research prelim exam topic and future research plans (less than 200 words), (4) Recommendations of any (up to three) robotics faculty members the student would like to serve as examiners, (5) Recommendations of any (up to three) robotics faculty members the student would prefer not serve as examiners; see <http://robotics.umich.edu/faculty/> for a list of eligible robotics faculty, and (6) An email from the advisor (an co-advisor, if applicable) indicating they agree to the student's participation in this exam for the given term. Any deviation from timely production of any of these documents should be discussed and approved in advance by the Graduate Program Chair.

Each student registered for the Part 2 exam must email Prof. Atkins and the Grad Coordinator a standard IEEE conference paper format document describing the research (no more than 8 pages; see [http://www.ieee.org/conferences\\_events/conferences/publishing/templates.html](http://www.ieee.org/conferences_events/conferences/publishing/templates.html) for format details).

Faculty examiners will be selected by the graduate committee based on consideration of student input and faculty availability constraints, the student is responsible for coordinating an examination date and time with the faculty examiners and returning this information to Prof. Atkins at least two weeks before the exam date. As with the qualifying examination, a conference room will be reserved.

**Important:** The student should correspond with faculty examiners by email and/or in person prior to the exam to ensure presentation and preparation expectations are clear, and then the student should prepare the research presentations based on a combination of inputs from the advisor, co-advisor, and examination committee. Students should prepare a presentation to last approximately 30 minutes without questions. Examiners are at liberty to ask questions before, during, and after the presentation.

**Grading:** Students are evaluated on a scale ranging from poor to excellent (0-4 point scale) in each of the following areas as described in more detail on the attached examiner grading sheet.

- Synthesis of course material for the student's research problem.
- Student input to the research project.
- Research conduct and methodology.
- Research outcomes.
- Written and oral communication: content, clarity, ability to answer questions.

Scores will be assigned by each faculty examiner along with comments. The graduate committee will present examination results to the robotics faculty who will collectively determine the exam outcome for each student based on feedback from examiners and advisor(s).

**Communication of Results:** The result of the research qualifying exam is communicated by the Graduate Chair to the student through an individual email the day the final decision is made, typically the first day the robotics graduate committee or full faculty can meet following exam completion. Students will not receive numerical results but will receive written comments from both the examiners and the graduate chair regarding the final decision.

**Retaking the Research-based Qualifying Exam:** A student who fails the research-based qualifying exam on the first try must obtain approval from their advisor to retake the exam and must then email Prof. Atkins with this confirmation. Only one Part 2 exam retake is permitted. This exam retake must be completed no later than the next offering of the exam, typically the term after the first research-based exam attempt. If the student does not receive support from the current advisor, the student must choose a new advisor who formally agrees to support the student for the exam retake and for the duration of the student's studies.

## Candidacy

Rackham expects students to achieve candidacy no later than three calendar years after the first enrollment in their doctoral program. Candidacy is not automatic; once all Robotics and Rackham requirements are met, a student must apply for candidacy by emailing the Graduate Program Coordinator. The student's advisor(s) must also approve the advancement via an email to the Graduate Coordinator.

### *Requirements*

1) Complete the 18 credit letter-graded graduate level course requirement (note: up to 6 credits of ROB 590 and 3 credits of ROB 690). ROB 501, ROB 550, breadth, depth, and cognate requirements must also be completed. Students without a relevant master's are not advised to advance to candidacy until they're close to meeting the 36 credit hour requirement

2) Pass the Qualifying exams.

3) Satisfy all Rackham candidacy requirements. Click here for further details:

<http://www.rackham.umich.edu/current-students/policies/academic-policies/section5#51> Please see page 3 of this document for the Robotics cognate policy.

4) Complete the College of Engineering's Responsible Conduct of Research and Scholarship (RCRS) program. This program consists of 4 distinct workshops, all 4 of which must be completed. For further information and to register for workshops see the [CoE RCRS website](#).

### *Course Enrollment*

Once a student has attained Candidacy status, he/she will enroll in 8 credits of ROB 995 each term. Tuition reduces to the Candidacy rate. See the [Registrar's Office website](#) for the current Candidacy tuition rate.

In addition to ROB 995, Candidates may elect either one course per term or more than one course for a total of no more than four credits without paying additional tuition beyond candidacy tuition. Courses may be taken for credit or as a visit (audit). A candidate who does not elect a course during a term of 995 enrollment may, in the next term, either register for courses for no more than 8 credits

or register for no more than two courses that total more than 8 credits. An additional course may not be taken in anticipation of taking none in a future term of 995 enrollment. Candidates who choose to take more courses than those for which they are eligible will be assessed additional tuition per credit hour. For more information please see the [Rackham Academic Policies](#).

It is the student's responsibility to cover the tuition costs for any courses taken in addition to the free course described above, even if the student is being funded through a fellowship, GSI or GSRA position.

## **Dissertation Committee Formation**

At least one month before the thesis proposal, the student must have their Dissertation Committee approved by both the Robotics Grad Chair and Rackham.

The completed [Dissertation Committee Form](#) should be sent by email to the Robotics Grad Coordinator. If requesting a committee member outside of U-M their CV as well as a short statement describing their expertise in the dissertation topic must accompany the Dissertation Committee Form.

In collaboration with the Dissertation Chair(s), the student forms a Dissertation Committee following specific guidelines regarding the composition of the Committee. A Robotics Ph.D. student's dissertation committee first must satisfy [Rackham's Guidelines for Dissertation Committees](#).

*Robotics Institute Dissertation Committee formation rules:*

1. The committee must consist of four or more members; at least two of the members must be affiliated with the Robotics program.
2. The Research Advisor will serve as Chair of the dissertation committee. The research advisor must be a Core Member of the Robotics Faculty. It is customary for the co-advisor (if applicable) to serve on the dissertation committee.
3. One of the Committee members must be designated as "cognate member." Cognate members must be a tenured-track faculty in a Rackham graduate program and be primarily engaged in a research area outside of the candidate's. The cognate member may or may not be a member of the Robotics faculty.
4. The Robotics Graduate Program Chair must approve the thesis committee.



## PhD Thesis Proposal

After passing the Qualifying Exam, a student continues to work with his/her Research Advisor who becomes the Dissertation Committee Chair(s). The student will write a concise Research Thesis Proposal and give a formal oral presentation of the work to the Dissertation Committee approximately 1 year before the Final Oral Defense. The Dissertation Chair(s) primary role is to guide the student toward completion of the Ph.D. and assists the student with forming their Dissertation Committee. The thesis proposal for students without a relevant MS would typically happen at the end of the 4th year (when they would have 1 year left). The thesis proposal for students with a relevant MS would typically happen at the end of the 3rd year (when they would have 1 year left).

When the student is ready to complete the Research Thesis Proposal, the student must complete the following:

1. Schedule an oral presentation with the Dissertation Committee.
2. Submit the written thesis proposal to the Dissertation Committee at least two weeks in advance of the oral presentation. The format (length and content) of the written document is up to the discretion of the candidate's Chair/Committee.

During the Thesis Proposal presentation, the student should:

1. Precisely identify and describe the area of research.
2. Demonstrate an in-depth understanding of the area including mastery of the literature on the subject area.
3. Give a general description of the research problem to be addressed.
4. Provide an outline of the methodology to be utilized.

During and after the Thesis Proposal presentation, the Dissertation Committee will explore the proposed research with the student in order to provide guidance and make an evaluation of its suitability. The committee will determine if the student has or does not have an acceptable proposal.

The [Ph.D. Thesis Proposal Form](#) must be completed and returned to the Graduate Coordinator after the Thesis Proposal.

Failure to have an acceptable proposal requires revising the proposal and within 12 months presenting another formal oral presentation that is deemed satisfactory by the committee.

Students entering the Ph.D. Program without a relevant Master's degree must write and orally present the Research Thesis Proposal within 48 months of entry. Students entering with a relevant Master's degree must present within 36 months.

Insufficient research progress could potentially result in the student being placed on academic probation.

## Dissertation Defense

### *Final Oral Defense*

Each Ph.D. Candidate must prepare a dissertation, giving evidence of his/her ability to conduct original, advanced research and to present the results of that research in well-written form. The student must also defend the work orally in an open examination called the Final Oral Defense. A final and complete copy of the written dissertation must be given to each member of the Dissertation Committee at least 14 business days before the scheduled date of the Final Oral Defense to allow sufficient time for a written evaluation. The Final Oral Defense will only be held if the committee deems the dissertation acceptable. Once all members of the Dissertation Committee find the dissertation acceptable, the Final Oral Defense is held.

It is very important to follow all of [Rackham's Doctoral Degree Requirements](#) which include a pre and post defense meeting.

### *Course Enrollment*

The student must be enrolled in 8 hours of ROB 995 the term of the Final Oral Defense. The student must defend and complete all Rackham degree requirements before the final doctoral degree deadline for the term.

### *Timing/Grace Period*

Rackham allows 3 additional weeks beyond the end of each semester for Ph.D. students to complete all of the doctoral degree requirements. This additional time is known as the Grace Period. The Grace Period enables the student to complete their work without needing to register for the new semester. However, the degree is still awarded at the end of the new semester. Rackham's Doctoral Degree Deadlines can be found [here](#).

## 6. STUDENT HANDBOOKS AND INTERNET RESOURCES

The Rackham Graduate School Student Handbook and the Engineering College Bulletin are among the numerous U-M publications available online. The Rackham Handbook gives details about the graduate degree requirements imposed by the Graduate School, and should be consulted by all graduate students. Some important topics include the continuous enrollment policy and fees.

Rackham Graduate School: <http://www.rackham.umich.edu>

College of Engineering: <http://www.engin.umich.edu/college/>

U-M Wolverine Access: <https://wolverineaccess.umich.edu/>

U-M Registrar: <http://ro.umich.edu>

Student Financial Services: <http://www.finance.umich.edu/finops/student>

U-M International Center: [internationalcenter.umich.edu](http://internationalcenter.umich.edu)

Mental Health Resources: <https://caps.umich.edu/article/um-mental-health-resources>

CoE Honor Code: <http://ossa.engin.umich.edu/honor-council/>

Student Rights and Responsibilities:

<https://oscr.umich.edu/article/statement-student-rights-and-responsibilities-1>

## Appendix

### Section 3.5.2 from [Rackham Graduate School Academic Policies](#)

#### 3.5.2.1 Placing a Student On Academic Probation

The advisor or graduate chair or director may recommend that a student be placed on academic probation. The decision to place a student on probation must be made by a faculty group of at least three persons to include, for example, the department chair (or the chair's designee), the graduate chair, and the advisor; the graduate committee of the program; or another committee constituted of faculty. A D.M.A. student who has been placed on academic probation will not be eligible for detached study ([section 2.3.1](#)).

#### 3.5.2.2 Length of the Probationary Period

The probationary period may be no shorter than two months of the fall or winter term and ordinarily conclude at the end of that term. For a student placed on academic probation within two months of the end of the fall term, the probationary period will extend into the winter term for a total of at least two months. For a student placed on academic probation within two months of the end of the winter term, the probationary period may include the spring or summer half-terms or the following fall term, for a total of at least two months. A student may be placed on academic probation starting in the spring or summer half term for a minimum of two months, and does not need to be enrolled during these half terms.

#### 3.5.2.3 Notifications

The graduate chair must notify the student and Rackham OARD in writing before the probationary period begins, explaining the reasons and conditions of probation; the start and end dates of the probationary period; funding support (see below); conditions, if any, the lifting of probation; and options for appeal (see below). A student who has been placed on probation may request a leave of absence from Rackham or withdraw ([sections 2.2.2, 2.2.3](#)). The leave or withdrawal will stop the clock on the probationary period, which resumes when the student returns to active status or is reinstated. Probation will remain in effect until the conditions are remedied or the student is dismissed.

#### 3.5.2.4 Funding a Student on Probation

The level of funding prior to academic probation should be continued through the probationary period.

At the end of the probationary period, the program may continue the student in the program or, alternatively, dismiss the student (section 3.5.3).

### **3.5.2.5 Option to Appeal Academic Probation or Dismissal**

The program must inform a student of options to appeal academic probation. The program should constitute a separate committee of review to consider appeals. Students may use the Graduate School's Academic Dispute Resolution process only for procedural issues of fair and equal treatment under the policy of the program, and not to appeal the academic reasons for the decision.

### **3.5.3 Academic Dismissal: Ph.D. and D.M.A. Programs**

Starting with the 2019 Fall Term, Ph.D. and D.M.A. programs will implement program-level policy for academic dismissal that is consistent with the following Graduate School guidelines.

At the end of a probationary period, and upon the recommendation of the graduate chair and with the consent of the Graduate School, a student may be dismissed from the program. The decision to dismiss a student must be made by a faculty group of at least three persons to include, for example, the department chair (or the chair's designee), the graduate chair, and the advisor; the graduate committee of the program; or another committee constituted of faculty. The graduate chair must notify Rackham OARD of a recommendation for dismissal.

#### **3.5.3.1 Option to Appeal Academic Dismissal: Ph.D. and D.M.A. Programs**

The program must inform a student of options to appeal a decision of academic dismissal. The program should constitute a separate committee of review to consider appeals. Students may use the Graduate School's Academic Dispute Resolution process only for procedural issues of fair and equal treatment under the policy of the program, and not to appeal the academic reasons for the decision.

Students who fail to meet standards of academic or professional integrity or who have been found responsible for violations of other University standards of conduct may be dismissed in accordance with separate procedures described in Rackham Academic and Professional Integrity Policy ([section 8](#)).