Ira A. Fulton Schools of Engineering

Arizona State University

Robotics & Autonomous Systems
An Interdisciplinary Graduate Program

Master of Science (MS)
Graduate Student Handbook
Spring 2023 and the 2023-2024 Academic Year

https://ras.engineering.asu.edu/

Contents

Program Overview

Robotics and autonomous systems are interdisciplinary technologies that impact manufacturing, transportation, aerospace, defense, healthcare, etc. The ASU Robotics Faculty Group includes faculty from several engineering disciplines, and a large number of graduate robotics-related engineering courses are already being offered at both the Tempe and Polytechnic campuses. Autonomous systems and robotics are related and extend the field of "traditional" robotics to emerging fields such as collective behavior, autonomous vehicles, advanced sensing technologies, etc. This interdisciplinary MS degree brings together students from various engineering backgrounds and allows them to take advantage of the broad variety of available courses and faculty.

The Master of Science (MS) in Robotics and Autonomous Systems has five concentrations, and applicants are required to select one concentration at the time of application.

Mechanical & Aerospace Engineering

This concentration is offered by the School of Engineering of Matter, Transport, and Energy at the Tempe campus. It is appropriate for students who wish to emphasize applications in mechanical or aerospace engineering and provides students with the necessary background and skills for a broad range of applications of robotics and autonomous systems. Students will get a solid theoretical and practical background in a variety of topics that include theory, design, and implementation of control systems, kinematics, and dynamics of rigid and non-rigid (flexible, soft) robotic systems, design, and bio-inspiration in controller design and hardware, swarm robotics, as well as embedded systems programming. Most importantly, students in this concentration will be exposed to state-of-the-art and emerging theories and implementations related to human-robot interaction, robotics, and automation in healthcare, manufacturing, automotive controls, as well as a plethora of everyday life applications of robotics and autonomous systems. This concentration prepares engineers for doctoral study or industrial positions that specialize in research, project management, and product innovation related to robotics and autonomous systems. Modern robotics and autonomous systems laboratory facilities are available to support research investigations.

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Systems Engineering

This concentration is offered by The School of Manufacturing Systems and Networks at the Polytechnic campus, in Mesa, AZ. It is appropriate for students who wish to emphasize applications in systems engineering. The systems concentration will prepare students to identify, model, analyze, interpret, optimize, and manage the multidimensional interactions of the ever-increasing complexity of modern mechatronic and robotic problems. Subject areas include mechatronics, controls, foldable robotics, soft robotics, medical robotics, design, additive manufacturing, and industrial automation. Engineering students that complete the systems concentration will be well prepared for doctoral study or industrial positions related to robotics and autonomous

systems as they will possess the necessary expertise to advance systems integration of key industry and government sectors, and to contribute to the body of knowledge on interdisciplinary methods, techniques, and strategies for designing and managing complex robotic systems.

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Electrical Engineering

This concentration is offered by the School of Electrical, Computer, and Energy Engineering at the Tempe campus. It is appropriate for students who wish to emphasize applications in electrical engineering. Students will get a solid theoretical and practical background in a variety of topics that include theory, design, and implementation of control systems, signal processing, real-time and embedded systems, computer vision, and machine learning. Students in this concentration will be exposed to state-of-the-art and emerging theories and implementations related to sensing, data processing, adaptive control, automated mobility, autonomous systems, human-machine interaction, robotic applications in various domains including but not limited to public safety, manufacturing, healthcare, automotive, and assistive technologies. This concentration prepares engineers for doctoral study or industrial positions that specialize in research, project management, and product innovation related to robotics and autonomous systems. Modern robotics and autonomous systems laboratory facilities are available to support research investigations.

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Artificial Intelligence

This concentration is offered by the School of Computing and Augmented Intelligence at the Tempe campus. It is appropriate for students who wish to emphasize applications in artificial intelligence/computer science. Students will get a solid theoretical and practical background in a variety of topics that facilitate the study of "intelligent agents" that is any robotic system that perceives its environment and takes actions that maximize its chance of successfully achieving its goals. Thus, students in this concentration will be exposed to the frontiers of the general topics in AI, including statistical machine learning, computer vision, natural language processing, knowledge retrieval and reasoning, and formal methods of planning. When compared to the other concentrations, the AI concentration focuses more on the algorithmic aspects of robotics. This concentration prepares engineers for doctoral study or industrial positions that specialize in research, development, project management, and product innovation related to autonomous intelligent systems. Modern robotics and autonomous systems laboratory facilities and state-of-the-art computing resources are available to support research investigations.

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Biomedical Engineering

This concentration is offered by the School of Biological and Health Systems Engineering at the Tempe Campus. It is appropriate for students who wish to emphasize applications in biomedical engineering. The biomedical engineering concentration will enable students to focus their education in the growing field of medical robotics, while at the same time allowing them to take a broad array of interdisciplinary courses and to interact with faculty in a variety of programs within the Fulton Schools of Engineering. This is an advanced degree, emphasizing competency in the rapidly growing fields of robotics and autonomous systems, with applications in biomedical engineering and medicine. Biomedical engineers work at the interface of technology and medicine on challenges that are critical to the advancement of health and scientific discovery.

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Program Admission Information

An applicant must fulfill the requirements of both the ASU Graduate College and the Ira A. Fulton Schools of Engineering.

Eligibility and GPA Requirements

An applicant must have a minimum of a bachelor's degree (or equivalent) or master's degree from a regionally accredited college or university in a related field such as engineering, physics, or mathematics. A minimum of a 3.0 cumulative GPA (scale is 4.0 = "A") in the last 60 hours of a student's bachelor's degree program is required.

Application Deadlines

Students can apply for and be admitted in either the spring or fall semesters. The priority deadline for fall semester admission is December 31, and the priority deadline for spring semester admission is August 15. To receive full consideration, submit all required documents by the deadline. International students must apply by April 15 for the fall semester and October 1 for the spring semester to ensure visa documents may be processed on-time.

Application Requirements

Applicants are required to submit:
- **Graduate admission application** at https://webapp4.asu.edu/dgsadmissions/Index.jsp and pay the application fee
- **Official transcripts**
- **Letter of intent/written statement**: The statement should explain professional goals and reasons for desiring to enroll in the M.S. program. A student interested in pursuing a thesis option should describe any research experience, indicate personal research interests, and identify two or three ASU RAS faculty with matching research interests.

- Professional resumé or curriculum vitae
- **GRE scores**
  - The GRE is waived for all students with a bachelor's degree from an ABET Accredited (or equivalent e.g. CEAB, UGC, EUR-ACE, AICTE, CEEAA) bachelor's programs are not required to take the GRE. If you meet those criteria, please contact the advising office for the concentration that you have applied to (contact information found [here](#)) after you have applied to the program in order to have the GRE waived
  - The GRE is required for any applicant who has **not** earned a bachelor's degree from an ABET Accredited Institution. GRE scores must be sent in order for your application to be reviewed.
  - The program does not require specific subject GRE scores. The ASU institution code is 4007, and there is no department code (use 0000 if required).
- **Proof of English proficiency**
  - The University requires all international applicants from a country whose native language is not English to provide the Test of English as a Foreign Language (TOEFL), the International English Language Testing System (IELTS), or the Pearson scores.
  - This program requires a minimum score of 575 (paper-based) or 90 (internet-based) TOEFL, 7 IELTS, 105 Duolingo, or 65 Pearson as expectations for admission.
  - Applications are not processed until the university receives official scores, which are valid for two years from the start date of the degree program.
  - Please address all TOEFL questions to Graduate Admissions. The ASU institution code is 4007 if department code is required use 0000.
  - If a student has completed coursework in the US, they can contact Graduate Admission to see if they qualify for a waiver.
  - Global Launch at ASU offers an online alternative to standardized testing for international students who are seeking admission to ASU but need proof of English proficiency. https://learnenglish.asu.edu/online/admission
- **Notice of Admission:** The unit submits its recommendation of admission to the Office of Graduate Admissions and the Office of Graduate Admissions sends the final admission decision to the applicant in writing. Students may check the application status on My ASU (my.asu.edu).

Accelerated Master's Degree Program

Select eligible students might be able to participate in the accelerated bachelor's/master's program within their school. Below is information on each of the concentrations, admission requirements, and program requirements.

- **Artificial Intelligence Concentration (AI):** Students pursuing a bachelor's degree in one of the following programs can apply to the MS in RAS – Artificial Intelligence Program:
  - Computer Science
  - Software Engineering

- o Computer Systems Engineering
- o Informatics
- **Electrical Engineering Concentration (EE):** Students pursuing a bachelor's degree in one of the following programs can apply to the MS in RAS- Electrical Engineering Program
  - o Electrical Engineering
  - o Electrical Engineering (Electric Power and Energy Systems)
- **Mechanical and Aerospace Engineering Concentration (MAE):** Students pursuing a bachelor's degree in one of the following programs can apply to the MS in RAS- Mechanical and Aerospace Engineering Program
  - o Mechanical Engineering (excluding concentrations: Energy and Environment and Computational Mechanics)
  - o Aerospace Engineering (Aeronautics, AVS GNC, and Astronautics)
- **Systems Engineering Concentration (SE):** Students pursuing a bachelor's degree in one of the following programs can apply to the MS in RAS- Systems Engineering Program
  - o Automotive Systems,
  - o Electrical Systems,
  - o Mechanical Engineering Systems,
  - o Robotics
  - o Manufacturing Engineering
- **GPA Requirement:** Students must have a 3.25 ASU GPA in their undergraduate program. Students must also have 75 credits completed before applying to the program. At this time, the Biomedical Engineering concentration does not have an accelerated master's option.
- **Application requirements:**
  - o Graduate Admission Application
  - o Proof of English Proficiency, if required
  - o Personal Statement
  - o Resume
  - o Accelerated master's application
- **Degree Requirements:** Students in the accelerated degree program must meet all degree requirements of the bachelor's and master's programs
  - o No more than 12 graduate credits may be brought over to the graduate program (This includes shared credits.):
    - RAS-AI: 9 credit hours may be shared. In total up to 12 graduate credit hours may be brought over to the graduate program.
    - RAS-EE: no more than 3 classes (9-12 credits) can be shared between both programs. If 9 credits are shared, an additional 3 credits can be reserved for use in the master's program.
    - RAS-MAE: no more than 9 credits can be shared between both programs and no more than 3 credits can be reserved for use in the master's program.
    - RAS-SE: no more than 3 classes (9 credits) can be shared between both programs and 3 credits can be reserved for use in the master's program.

- o 400-level courses are not allowed
- o Graduate research credits cannot be completed during your undergraduate program.
- **Satisfactory Progress as a Graduate Student:** All accelerated master's students must maintain a GPA of 3.0 or higher (Cumulative, Graduate and IPOS). If a student falls below a 3.0 GPA, they are placed on probation and provided the timeframe in which the GPA must be raised to the satisfactory level. Students who do not raise their GPA to a 3.0 within the provided timeline risk dismissal from the program. Please Note: any 500 level courses taken as an undergraduate student will immediately count towards your satisfactory progress GPA calculation once you become a graduate student.

Recommended Academic Preparation

Robotics and Autonomous Systems graduate students should know about the following topics before applying for the program at Arizona State University:
- MAT 267: Calculus for Engineers III
- MAT 242: Elementary Linear Algebra
- PHY 121: University Physics I: Mechanics
- MAE 318 System Dynamics and Control I
  Prerequisite(s) with C or better: EEE 202; MAE 202 or 212; MAE 384; MAT 267 or 272; PHY 131; PHY 132; Aerospace or Mechanical Engineering BSE major; Pre- or corequisite(s): MAE 301 with C or better if completed
- MAE 417 System Dynamics and Control II
  Prerequisites are Mechanical Engineering BSE or Aerospace Engineering BSE major: MAE 318 with C or better

Although any engineering student can apply to all concentrations, there are some suggestions for previous background for each concentration:

Mechanical and Aerospace Engineering: Students applying to the Mechanical and Aerospace concentration are expected to possess basic knowledge in key relevant areas, e.g. Kinematics; Dynamics; Programming in MATLAB; System Dynamics and Control; or similar topics. Indicative ASU courses include: MAE201, MAE202, MAE215, MAE318, MAE417.

Systems Engineering: Students applying to the Systems Engineering concentration are expected to possess basic knowledge in key relevant areas, e.g. Feedback and Controls; Embedded Systems; Programming (preferably C or similar language, MATLAB-Simulink-toolboxes). Dynamics; or similar topics. Indicative ASU courses include: EGR 219, EGR 455, EGR 456, EGR 433, PHY 321.

Electrical Engineering: Students applying to the Electrical Engineering concentration are expected to possess basic knowledge in key relevant areas, e.g. Signals and Systems; Feedback and Controls; Computer Architecture & Organization; Embedded Systems; Random Signal Analysis; Programming (preferably C or similar language, MATLAB-Simulink-toolboxes); or similar topics. Indicative ASU courses include: EEE 203, EEE 230, EEE 350, CSE 220, EEE480, EEE481.

Artificial Intelligence: Students applying to the Artificial Intelligence concentration are expected to possess basic knowledge in key relevant areas, e.g. Programming Languages; Discrete Mathematics; Data Structures and Algorithms; or similar topics. Indicative ASU courses include: CSE 220 or 240; MAT 243 or 300; CSE 310.

Biomedical Engineering: students applying to the Biomedical Engineering concentration are expected to possess basic knowledge in key relevant areas to Biomedical Engineering.

Transferring Between Concentrations or Programs
Students who want to change between concentrations or change to another degree program must submit a new application with Graduate Admission. If admitted, the Graduate College's pre-admission policy states that a student is allowed to use only twelve (12) credits with grades of "B" or better from the original program to the new program. However, petitions to the pre-admission policy will be considered on a case-by-case basis.

Program Requirements

A minimum of 30 credit hours of coursework beyond the bachelor's degree are required to complete the MS degree. All master's students are required to develop and submit an Interactive Plan of Study (iPOS) through your MyASU page during the first semester at ASU. The iPOS should be developed with the aid of the student's academic advisor. The graduate academic advisor, acting on behalf of the graduate program chair, will initially advise the student. Students pursuing the non-thesis option will list the program chair as their faculty advisor. Students pursuing the thesis option should seek out a faculty member in his or her area of study to serve as the thesis advisor and committee chair.

Total Number of Credit Hours: 30
- Core: 6
- Concentration: 6
- Electives: 12 to 18
- Thesis (6) or Applied Project (3) or Portfolio (0)

Core courses (6 credits)
MAE 501 Linear Algebra in Engineering **OR** EGR 501/598 Applied Linear Algebra for Engineers

MAE 547 Modeling and Control of Robots (MAE 501 is a pre/corequisite) **OR** EGR 545 Robotics 1

- It is highly recommended that you complete MAE 501 or EGR 501/598 before you register for MAE 547 or EGR 545
- RAS-MAE students are required to take MAE 501 and MAE 547. EGR versions of the core courses are not accepted.

- EGR 545 has been added as an option to the core course requirements as of the Fall 2022 semester. Students admitted prior to the Fall 2022 semester should speak with their advisor if they have questions about the core courses.
- Students in the RAS-EE, RAS-AI, RAS-SE, and RAS-BE are **highly encouraged** to take the EGR core courses

Please note that transfer credit cannot count towards the core course requirements unless the credit was earned at ASU.

Concentration courses

All students must select one of the following five concentrations at the time of application:

Mechanical & Aerospace Engineering Concentration (6 credit hours)

MAE 506 Advanced System Modeling, Dynamics, and Control

One class from the following list

- MAE 502 Partial Differential Equations
- MAE 503 Finite Elements in Engineering
- MAE 505 Perturbation Methods
- MAE 507 Fundamentals of Control and Optimization
- MAE 508 Digital Control: Design and Implementation
- MAE 509 LMI Methods in Optimal and Robust Control
- MAE 510 Dynamics and Vibrations
- MAE 514 Vibration Analysis
- MAE 520 Stress Analysis
- MAE 521 Structural Optimization
- MAE 542 Design Geometry and Kinematics
- MAE 548 Prob Methods for Eng Des/Analy
- MAE 566 Rotary-Wing Aerodynamics
- MAE 598 Bio-Inspired Robots
- MAE 598 Multi-Robot Systems
- MAE 598 Quantum Mech Eng: SW and HW of Quantum Computers
- EGR 546 Robotic Systems- II
- IEE 576 Network Optimization and Algorithms

Systems Engineering Concentration (6 credit hours)

EGR 550 Mechatronic Systems

Plus, one class from the following list:

- EGR 520 Engineering Analysis I
- EGR 521 Engineering Analysis II
- EGR 555 Mechatronics Device Innovation
- EGR 560 Vehicle Dynamics and Control

- EGR 557 Foldable Robots
- EGR 598/575 Applied AI and Machine Learning
- EGR 598/546 Robotics II
- EGR 598 System Control and Optimization
- EGR 598 Topic: Zero Emissions Vehicles
- EGR 598 Topic: Transforms and Systems Modeling
- EGR 598 Topic: Mechanical Engineering Systems
- EGR 598 Topic: Power Electronic Converters and Systems
- EGR 608 Adv Simulation
- EGR 611 Complex Engineering Systems
- IEE 576 Network Optimization and Algorithms
- SER 594 Software Engineering for Machine Learning
- SES 598 Autonomous Exploration Systems

Electrical Engineering Concentration (6 credit hours)

EEE 582 Linear System Theory (3)

Select one from the following list

- EEE 508 Digital Image and Video Processing and Compression
- EEE 511 Artificial Neural Computation
- EEE 515 Machine Vision and Pattern Recognition
- EEE 556 Detection/Estimation Theory
- EEE 586 Nonlinear Control Systems
- EEE 588 Design of Multivariable Control Systems
- EEE 589 Convex Optimization
- EEE 591 Feedback Systems
- EEE 591 Computer Control Systems
- EEE 591 Quantum Optics and Quantum Information
- EEE 591 Real-Time DSP Systems
- EEE 591 Machine Learning Basics with Deployment to FPGAs
- EEE 591 Quantum Mechanics for Engineers
- EEE 591 Python for Rapid Engineering Solutions
- EEE 598 Deep Learning for Media Processing and Understanding
- EEE 598 Game Theory
- EEE 598 Introduction to Electric and Autonomous Vehicles
- EEE 598 Statistical Machine Learning
- EEE 598 Data-Driven Optimization: Models and Applications
- EEE 598 Neuromorphic Computing Hardware Design
- EEE 598 Speech and Audio Processing and Perception
- EEE 598 Introduction to Electric and Autonomous Vehicles
- EEE 598 Remote Sensing and Synthetic Aperture Imaging
- EEE 598 Statistical Machine Learning: Theory to Practice
- EEE 598 Reinforcement Learning in Robotics
- EEE 686 Adaptive Control
- EGR 546 Robotic Systems- II
- IEE 576 Network Optimization and Algorithms

Artificial Intelligence Concentration (6 credit hours)

CSE 571 Artificial Intelligence (3)

One class from the following list

- CSE 511 Data Processing at Scale
- CSE 522 Real-Time Embedded Systems
- CSE 535 Mobile Computing
- CSE 546 Cloud Computing
- CSE 551 Foundations of Algorithms
- CSE 561 Modeling and Simulation Theory and Application
- CSE 574 Planning and Learning Methods in AI
- CSE 575 Statistical Machine Learning
- CSE 576 Topics in Natural Language Processing
- CSE 578 Data Visualization
- CSE 591 Topic: Neuro Symbolic Reasoning
- CSE 591/598 Advances in Robot Learning
- CSE 591/598 Safe Autonomy for Cyber-Physical Systems
- CSE 591/598 Human-Aware Robotics
- CSE 591/598 Perception in Robotics
- CSE 598 Topic: Smart City Infrastructure and Technology
- CSE 598 Topic: Bio-Inspired AI and Optimization
- CSE 598 Topic: Statistical Learning Theory
- CSE 598 Topic: Modern Temporal Learning
- CSE 598 Topic: Data-Intensive Systems for Machine Learning
- CSE 598 Topic: Quantum Computation
- CSE 598 Topic: Secure Computation for Machine Learning
- CSE 598 Topic: Data-Intensive Systems for Machine Learning
- CSE 598 Topic: Secure Computation for Machine Learning
- CSE 598 Integ Robot Learning w Human Robot Collaboration
- CSE 691 Topic: Topics in Reinforcement Learning
- CSE 691 Topic: Current Topics in Cybersecurity
- EGR 546 Robotic Systems II
- IEE 576 Network Optimization and Algorithms
- IEE 598 Optimal Foraging Theory: From Biology to Engineering

Biomedical Engineering Concentration (6 credit hours)

BME 564 Cyber Biomedical Systems (3)

Choose one course from the following:

- BME 507 Introduction to Digital Image Processing and Analysis (3)
- BME 521 Neuromuscular Control Systems (3)
- BME 526 Introduction to Neural Engineering (3)
- BME 527 Biomedical Device Design (3)
- BME 556 Human Systems Neuroscience (4)
- BME 561 Clinical Neuroscience (3)

- BME 565 Magnetic Resonance Imaging (3)
- BME 566 Medical Imaging Instrumentation (3)
- BME 567 Tissue Engineering and Regenerative Medicine (3)
- BME 568 Human Factors and System Design in Assistive Technologies (3)

Electives (12 to 18 credit hours)

Ideally, at least two courses (6 credit hours) must be chosen from outside the student's concentration area among the courses listed above. Electives and course offerings are subject to change. Students might need to request overrides for courses that are not in their concentration (EX: RAS-EE students might need to request an override for CSE courses). Please speak to your assigned academic advisor if you need to request an override for one of the courses above. The electives must be graduate courses in science, engineering, mathematics, or others approved by the Graduate Program Committee.

Reading and Conference (CSE 590/EEE 590/MAE 590/EGR 590/BME 590) might be approved in certain situations. Reading and Conference is an independent study in which a student meets regularly with a faculty member to discuss assignments. The course may include such assignments as intensive reading in a specialized area, writing a synthesis of literature on a specified topic, or writing a literature review of a topic. Not all requests for reading and conference will be approved. The appropriate form needs to be submitted to the student's advising office prior to the end of the registration period in which they are requesting the course. Reading and conference can only be completed one time for up to 3 credits or less that would count as elective credits for the student's plan of study. Only non-thesis and applied project students may request a reading and conference course. Many faculty and students will utilize Reading and Conference as a way to determine if doing a thesis together will work. Once a student is working on their thesis under a faculty's supervision, they should not use Reading and Conference as an elective since they should be registered for thesis credits instead. Reading and conference credits are concentration specific and can NOT be transferred to other concentrations.

Culminating Events (0 to 6 credit hours)

Students are free to choose from among the following culminating experiences:
- Portfolio (no course credit hours)
  - As of the fall 2022 semester, this will also be the default option for students in the program
- Applied Project (requires 3 credit hours of CSE, 593, EEE 593, MAE 593, EGR 593, or BME 593)
- Thesis (requires 6 credit hours of MAE 599, EGR 599, EEE 599, CSE 599, or BME 599)

Culminating event descriptions and requirements

Portfolio
The portfolio is the default option for all students in the program.

The Portfolio is a sample of the significant projects that a graduate student has carried out during his/her graduate studies showcasing the quality of the graduate education he/she has received. Students choosing the MS portfolio option must select three significant projects from previously completed graduate RAS concentration coursework listed on their approved iPOS, unless they are in the Artificial Intelligence concentration (please see below). When submitting the portfolio, students should include the following:
- A cover page which includes the student's name, program and date.
- An executive summary of each project, why each project was selected, and whether they were single or group projects. If group projects were chosen, students need to describe their individual contribution.
- The original projects. These can include PDFs, power points, and/or word documents.

The Graduate Program Chair will be solely responsible for judging the quality of the portfolio and determining if it is satisfactory for the required culminating event.

Artificial Intelligence Concentration: All students admitted to the MS (Non-Thesis) degree program must complete a project portfolio. The portfolio is a compilation of two completed projects that were finished in the concentration courses **with a grade of "B" or better;** students must write a portfolio report that includes the highlights of the two projects.

Applied Project

A student completing the Applied Project will be supervised by a faculty member or a qualified faculty member from outside of the program who has been approved by the Graduate Program Chair and the Graduate College. Consequently, to complete an Applied Project a student must first obtain approval of a faculty member to work with them on a project, and subsequent approval of the Graduate Program Chair. The faculty advisor is then responsible for specifying the requirements of the project and for reviewing and approving the final report.

The Applied Project is a demonstration of application of the theory of robotics to solve a practical technical problem of general interest. The subject matter of an Applied Project is more flexible than that of a thesis since the result is not expected to be published, although the project may directly or indirectly support research programs. The faculty advisor has responsibility for establishing the requirements of the project and for approval of the final written report and presentation. However, in all cases, the student must prepare and present the applied project to the faculty advisor and discuss the implementation and results of their project. This presentation will be open to all graduate students. A student will be considered eligible for graduation when the sponsoring faculty member approves the report and the presentation and a grade of B or better is assigned on the Applied Project course.

You must be pre-approved to register for the applied project course, CSE 593/EEE 593/MAE 593/ EGR 593/BME 593. If you are interested in pursuing an applied project, schedule an appointment with your academic advisor.

Thesis
The thesis option is the research master's degree. A member of the corresponding Graduate Faculty (with co-chair or chair status as specified on the RAS website) must agree to serve as the program committee chair (faculty advisor) for a student to be transferred to the MS—thesis degree program. The Graduate Academic Advising Office will need to have confirmation in writing (email is acceptable) from the faculty member agreeing to serve as the thesis chair before a plan change is made to move to the MS—thesis degree. The program committee chair, in consultation with the student, will establish a Program Committee. It shall be composed of a minimum of three members from the ASU faculty with at least two being from the RAS Faculty. If the committee chair has co-chair status on the graduate faculty, the program committee must include a RAS faculty member with the chair or co-chair status serving as second co-chair. Participation of individuals from institutions external to ASU is encouraged but must be approved by the Graduate Program Chair and the Graduate College.

Once the thesis is completed, the student will submit it to the committee members. There will be an open oral defense following the completion of the thesis. A student can schedule the defense after the student's committee chair has approved the student's thesis format. The student must schedule their defense on My ASU at least 10 working days prior to the defense date.

The supervisory committee evaluates the thesis and the student's performance on the defense. The committee accepts the thesis, accepts it with changes, or rejects it. A rejected decision is final.

Steps to Preparing for Your Defense
Prior to defense:
1. Obtain a consensus of approval from the committee chair and members to proceed with the oral defense.
2. Schedule a date and time with your committee for the oral defense.
3. Important: Ensure that a minimum of 50% of the official committee be physically present at the defense. If at least 50% of the committee cannot be physically present, the defense must be rescheduled. Please see Appendix I for Absent Committee Member Procedures
4. Visit the Graduate College website to become familiar with the dates and deadlines on format approval and oral defense.

10 days prior to the defense:
These steps are required to be completed at least 10 working days prior to the date of oral defense.
1. Reserve a room with the unit concentration you are pursuing:
   a. Artificial Intelligence: SCAI front desk,

      b. Electrical Engineering: See the Academic Advisor
      c. Mechanical & Aerospace Engineering: See the Academic Advisor at least 15 days prior to the planned defense date.
      d. Systems Engineering: See the Academic Advisor
      e. Biomedical Engineering: See the Academic Advisor at least 15 days prior to the planned defense date.

2. Submit an electronic version of your abstract with title, full names of your committee members, defense date/time/place, and your name as you want it to appear on the defense announcement within your unit for announcement purposes. (See the unit academic advisor)
3. Schedule your defense on My ASU at least 10 working days prior to the defense with the Graduate College.

On the day of the defense:
1. Set up all your equipment at least one half-hour before your presentation to make sure they work.

After the defense:
1. Your committee will discuss the results of the exam with you and may have additional comments for you. In the end, the committee will make a recommendation: Pass, Pass with minor revisions, Pass with major revisions, or Fail.
2. A fail decision is final.
3. Revisions are normal and are expected to be completed within one year. This includes remaining registered until the finished document has been uploaded to ProQuest.
4. Follow the steps on My ASU for uploading your final thesis through the Graduate College and ProQuest.

Curricular Practical Training (CPT) and Optional Practical Training (OPT)

Curricular Practical Training
Internship (CPT) is an academic experience usually obtained at off-campus locations. CPT allows students to apply knowledge and skills gained in coursework to professional settings. It is intended as a unique, hands-on learning experience to provide students with valuable skills that they can use upon graduation. Accordingly, it is not available to full-time or part-time workers regularly employed by the company where the internship is proposed.

Internship (CPT) is available to both domestic and international students. International students need to be aware of immigration policies and regulations to not jeopardize their academic status. It is strongly recommended that international students consult the International Students and Scholars Center (ISSC). Students will be required to submit the required documentation to obtain work authorization from ISSC.

The internship (CPT) experience (up to three 1-credit CSE 584/EEE 584/EGR 584/MAE 584/BME 584) must be included as part of the student's Program of Study. It is highly recommended that the internship (CPT) course(s) be listed at the initial submission of the student's iPOS during the first semester of study.

Internship (CPT) should occur prior to the student completing the required 30 hours. CPT cannot be the only course remaining in the last semester of study. An internship course cannot be added to an approved iPOS once all coursework has been completed. Exceptions may be made if the internship is relevant to thesis research. The Graduate Program Chair will determine the need for a CPT internship in such cases in consultation with the Graduate Academic Advisor.

To be eligible for internship all students must be in good academic standing. Please refer to your department's specific policies and procedures for CPT processing. Students cannot be an RA or TA when they are participating in an internship.

Internships cannot start before the semester or session students enroll in the CPT credit. For example, if you are interested in doing an internship in the summer semester, you cannot start working until the summer semester officially starts (1st day of classes). Exceptions are given to students who provide proper justification from the company supporting this request.

Internship end dates can be the last day of classes or continue until the day before classes start in the following semester (unless it is the student's final semester - contact your academic advisor). Refer to the Academic Calendar for semester start and end dates.

Required documents and forms for the internship proposal must be submitted to the respective RAS concentration advising office two to four weeks before the beginning of the semester in which the internship is planned. Students will not be able to request late-add registration of the internship credit to their class schedule after the drop/add deadline of each semester.

Below are the GPA requirements and restrictions for students to follow based on which semester they will be doing an internship in.

Summer semesters-

- Minimum GPA required: 3.0 (all GPAs must be at least 3.0)
- Full time or part time is allowed
- In state or out of state is allowed

Fall and spring semesters-

- For GPA's between 3.0-3.24
    - In state internships are allowed, out of state internships are NOT allowed
    - Part time is allowed, full time is NOT allowed
- For GPAs above 3.25

- In state and out of state is allowed
- Part time and full time is allowed
  - Regardless of GPA, any student doing an internship in the fall/spring semester must follow ISSC policies regarding campus presence and be registered for the proper courses per their iPOS

The following policies apply to all students doing an internship regardless of the semester the internship occurs.

- Full-time CPT is 21 hours or more. Part-time CPT is 20 hours or less.
- For students doing CPT in their last semester, the end date of their internship is the conferral date if they are not a thesis student. If the student is completing their thesis defense while doing an internship, their internship end date must be their thesis defense date or earlier.

Renege: (verb) to fail to carry out a promise or commitment

It is unethical for students to continue to seek or consider other employment opportunities once an offer has been accepted. The RAS Program expects students to honor an acceptance and immediately stop all employment seeking activities.

Never accept a job and turn it down if "something better" comes along. Not only is it inconsiderate and unprofessional, but it also reflects badly on Arizona State University and might negatively impact another ASU student's opportunities with that employer. Also, employers communicate with each other, and you don't want to get a bad reputation.

After you have given your decision, careful consideration and accepted an offer, stop looking. Inform other employers who have extended offers that you have accepted another position. Don't accept further interview invitations or search further. Please refer to NACE's "Playing Fair…Your Rights and Responsibilities as a Job Seeker" to become familiar with Principles for Professional Practice.

Students who accept an offer from an organization and later renege the offer will be prohibited from requesting future internship opportunities pending a meeting with the Assistant Director.

Required report

A two-page typed minimum final report is required before a grade and credit is given. The final report must be submitted to the internship supervisor for comments and then submitted for evaluation following the instructions on the RAS CPT website.

Optional Practical Training (OPT)
Please visit the International Students and Scholars Center website for details regarding OPT and Pre-OPT. Students must be in good academic standing and have an approved iPOS. A student does (Pre-) OPT at their own risk since if the student doesn't graduate in the semester indicated on the iPOS, no letter will be issued by the advising office to

support a later graduation date unless the delay is for reasons beyond the control of the student.

Program and University Procedures and Policies

Student Code of Conduct and Academic Integrity
The highest standards of academic integrity are expected of all graduate students, both in the academic coursework and in their related research activities. The failure of any graduate student to meet these standards may result in serious consequences including suspension or expulsion from the university and/or other sanctions as specified in the academic integrity policies of individual colleges as well as the university.

Violations of academic integrity include, but are not limited to: cheating, fabrication, tampering, plagiarism, or aiding and/or facilitating such activities. At the graduate level, it is expected that students are familiar with these issues and each student must take personal responsibility in their work. Also, graduate students are expected to follow university guidelines related to the Student Code of Conduct. University policies related to academic integrity and code of conduct are available in the Office of Student Life at https://provost.asu.edu/academic-integrity/policy.

Research Standards for Publication of Thesis
Graduate research is the study of an issue that is of sufficient breadth and depth to be publishable in a concentration-related journal. The effort should reflect a minimum of 750 hours of thoughtful work for a thesis. The research should follow the 'scientific method' and thus be both objective and reproducible. The thesis should demonstrate independent, original, and creative inquiry. There should be predefined hypotheses or developmental goals and objectives that are measurable and can be tested. The document should demonstrate proficiency with written English and should conform to the Graduate College format guidelines.

Satisfactory Progress, Academic Probation, Progress Probation, and Removal from the Program
At the end of the student's first completed semester and every semester thereafter, the school will conduct an audit to determine if the student is maintaining the required minimum satisfactory progress, including progress on academic (GPAs and deficiencies) and probationary issues. Any student that is not in compliance with the satisfactory academic/ progress requirements is notified that she/he is either:

- on academic probation and is given the next 9 credit hours or two semesters (fall and spring) to bring the GPA up to the proper level or
- on continued progress probation and is required to meet the conditions outlined in the continued probation letter.

Failure to properly remediate the GPA or the conditions outlined in the letter within the time frame will result in the school recommending that the student be dismissed from the program.

Note: Fully admitted students who take optional summer courses are placed on probation after the summer term if the earned grade(s) causes their GPA to fall below the satisfactory progress GPA minimum.

If applicable, the above-noted audit will also review each student's progress towards removing enrollment deficiency courses and/or any other degree requirement milestone(s). Failure to satisfactorily complete all deficiency course(s) and/or required milestones by the stipulated deadline may result in a recommendation for dismissal to the Graduate College.

All students are placed in one of four categories:

Satisfactory Progress
Satisfactory progress means that the student does not have any academic and progress probationary issues. In addition to the probationary rules, satisfactory progress includes communication each semester with the student's faculty advisor regarding his or her progress.

Academic Probation
Academic probation pertains to grades that might affect program and university policies including graduation. The following are notices/letters you will receive if one of these pertains to your academics:
- GPA below 3.0 in approved iPOS courses
- Overall post-baccalaureate (cumulative) GPA below 3.0
- Overall graduate (500 level or above) GPA below 3.0

Progress Probation
Progress probation pertains to issues dealing with making progress towards a degree. The following are notices/letters you will receive if one of these pertains to your academics:
- Failure to complete core courses within the first year of study
- Failure to file the iPOS at the end of the first semester
- Failure to pass the culminating event that is required for the concentration: Comprehensive Examination, Applied Project, or Portfolio
- Failure to make satisfactory progress towards completing the thesis, this includes maintaining regular contact with your thesis committee chair.

Removal from the Program
A student is recommended for removal from the program if he/she fails to meet the probationary standards placed upon him/her in the semester mentioned in the probationary letter. The student will receive a letter from the program explaining the reasons for the removal. The student will have 5 calendar days from the date of the letter to appeal the decision. The Graduate Programs Committee (GPC) will review the case and will make the necessary recommendation. The Graduate Program Chair, on behalf of the GPC, will provide a written explanation of the outcome. If the outcome is favorable, the student will have to meet all the outlined requirements at the end of the specified period. The student will be required to sign an agreement acknowledging the

recommendations and the consequences if the requirements are not met. If the GPC recommends that the appeal is not granted in favor of the student, the Graduate Program Chair, on behalf of the GPC, will recommend to the Vice Dean of Academic Affairs to remove the student from the program. The Ira A. Fulton Schools Standards Committee reviews the student's case and makes the final ruling to the Associate Dean of Graduate College and the program. If the appeal is not granted in favor of the student, the Vice Dean of Academic and Student Affairs will recommend to Graduate College to remove the student from the program. Graduate College makes the final decision to dismiss the student from the program. Please refer to the Graduate College website for policies and procedures or contact the graduate advisor in your respective concentration advising center.

Continuous Enrollment and Leave of Absence Policies

Once admitted to a graduate degree program or graduate certificate program, students must be registered for a minimum of one graduate level credit hour during all phases of their graduate education, including the terms in which they are admitted and graduate. This includes periods when students are engaged in research, conducting a doctoral prospectus, working on or defending theses or dissertations, taking comprehensive examinations, taking Graduate Foreign Language Examinations or in any other way utilizing university resources, facilities or faculty time.

Registration for every fall semester and spring semester is required. Summer registration is required for students taking examinations, completing culminating experiences, defending theses or dissertations or graduating from the degree program.

To maintain continuous enrollment, the credit hour(s) must:
- Appear on the student's Interactive Plan of Study, OR
- Be research (592), thesis (599), or continuing registration (595), OR
- Be a graduate-level course.

Grades of "W" and/or "X" are not considered valid registration for continuous enrollment purposes. "W" grades are received when students officially withdraw from a course after the drop/add period. "X" grades are received for audit courses. Additionally, students completing work for a course in which they received a grade of "I" must maintain continuous enrollment as defined previously. Graduate students have one year to complete work for an incomplete grade; if the work is not complete and the grade changes within one year, the "I" grade becomes permanent and will remain on the students' transcripts. Additional information regarding incomplete grades can be found at asu.edu/aad/manuals/ssm/ssm203-09.html.

Leave of Absence
Graduate students planning to discontinue registration for a semester or more must submit a Leave of Absence request via their Interactive Plan of Study (iPOS). Requests should have enough detail to understand the situation thoroughly and include a plan for continuing in a future semester. This request must be submitted and approved **before** the anticipated semester of non-registration. Students may request a maximum of two semesters of leave during their entire program. Having an approved Leave of Absence

by the Graduate College will enable students to re-enter their program without reapplying to the university.

Students who do not register for a fall or spring semester without an approved Leave of Absence are considered withdrawn from the university under the assumption that they have decided to discontinue their program. Students removed for this reason may reapply for admission to resume their degree program; the application will be considered along with all other new applications to the degree program.

Students with a Graduate College approved Leave of Absence are not required to pay tuition and/or fees, but in turn, are not permitted to place any demands on university faculty or use any university resources. These resources include university libraries, laboratories, recreation facilities, or faculty and staff time.

Maximum Time Limit
All work toward an MS degree must be completed within six consecutive years. The six years begin with the semester and year of admission to the program. Graduate courses taken prior to admission that are included in the iPOS must have been completed within three years of the semester and year of admission to the program.

Concurrent Degrees
A student may pursue concurrent master's degrees with prior written approval from the head of the academic unit for each degree program and the Graduate College office. A separate online application is required for each degree program. A maximum of 20 percent of the minimum total semester hours for the completion of both degrees may be common hours shared between the Plans of Study. The total number of hours common to both degree programs may vary from this maximum value only when the Graduate College has formally approved coordinated degree programs.

Coursework common to both programs must constitute a well-planned and meaningful part of each of the programs and may only include coursework completed after admission to both degree programs. In all cases, the guidelines below must be followed:
1. The student must maintain continuous enrollment as previously defined. Registration in both programs may be required each semester, please see the academic unit for specific satisfactory academic progress and program rules. Requests to maintain continuous enrollment forms will apply to both programs; students may not be registered for coursework in either program if approved.
2. Graduate credit transferred from another institution may be applied toward only one-degree program.
3. Culminating experiences (e.g. capstone courses, theses, applied projects) and comprehensive examinations cannot be shared between concurrent degree programs.
4. The six-year maximum time limit for completing degree requirements and graduation apply to each concurrent degree individually.

Refer to http://graduate.asu.edu/policies-procedures for the most recent Graduate College policies.

Pursuing two concurrent RAS degrees is not allowed in any of the concentrations.

Financial Assistance and/or Fellowships
Students interested in funding should contact faculty members to inquire about their funded projects for potential hourly or assistantship positions. We also encourage our students to explore assistantships available outside of the program and the Fulton Schools of Engineering, as well as explore the Graduate College website.

Requirements for Research Assistants (RA) and Teaching Assistants (TA)
Students awarded an assistantship within the Ira A. Fulton Schools of Engineering are required to be registered for 12 credit hours (no more, no less). Audit credit hours do not count towards the 12 credit hours. Students who obtain an assistantship outside the Ira A. Fulton Schools of Engineering are required to follow the policy of the unit that hires them.

TAs and RAs are treated as residents for tuition purposes. To be eligible for tuition remission, TAs, and RAs must be employed a minimum of 10 hours per week (25 percent Full Time Equivalency {FTE}). TAs/RAs working 10-19 hours per week (25-49 percent FTE) receive a 50 percent remission of tuition for the semester or summer session of their employment. TAs/RAs working 20 hours per week (50 percent FTE) do not pay tuition during the semester or summer session of their employment. In addition, the university pays the individual's health insurance premium for those TAs and RAs working 20 hours per week (50 percent FTE). The student is responsible for fees other than tuition.

TAs are required to meet English language proficiency requirements set by the University. Those requirements can be found on the [International Teaching Assistant](#) website from Global Launch. Each department handles TA hiring differently. Students should reach out to the department that they would like to be hired by for more information on how to apply for a TA position.

Program and University Resources

Students are expected to become familiar with the university and the program policies and procedures and abide by the terms set forth. Information is available both online and by hardcopy upon request. Most importantly, you should visit the following websites:
- [Graduate College](#) (policies and procedures section)
- [Schedule of Classes](#)
- [International Student and Scholars](#) Center (if applicable)
- [Robotics & Autonomous Systems program](#)
- [Ira A. Fulton Schools of Engineering](#)

Student organizations are excellent opportunities to learn about career possibilities as many of the student groups operate in conjunction with industry professional societies … get involved today! Please visit the Fulton Student Organizations website for a list of student organizations.

Diversity, Inclusion, and Land Use Statement

Arizona State University, The Ira A. Fulton Schools of Engineering (IAFSE), and all the schools within IAFSE upholds, values, and cherishes student and faculty diversity, no matter the circumstance. As members of the ASU community, we are charged with challenging injustices and social inequities of any kind through education. These values are an integral part of our standing as an institution and must be upheld by all members of the ASU community, including but not limited to all IAFSE staff, faculty, and students. ASU is a comprehensive public research university, measured not by whom it excludes, but by whom it includes and how they succeed; advancing research and discovery of public value; and assuming fundamental responsibility for the economic, social, cultural, and overall health of the communities it serves.

Title IX

ASU prohibits all forms of discrimination, harassment and retaliation. To view ASU's policy please see https://www.asu.edu/aad/manuals/acd/acd401.html.

Title IX protects individuals from discrimination based on sex in any educational program or activity operated by recipients of federal financial assistance. As required by Title IX, ASU does not discriminate on the basis of sex in the education programs or activities that we operate, including in admission and employment. Inquiries concerning the application of Title IX may be referred to the Title IX Coordinator or to the U.S. Department of Education, Assistant Secretary, or both. Contact titleixcoordinator@asu.edu or 480-965-0696 for more information. Office located at 1120 S. Cady Mall, INTDSB 284. For information on making a report please go to www.asu.edu/reportit/.

Archived Editions of This Handbook

There are archived versions of this handbook and can be found on the RAS Handbook website.