Edmund A. Hajim School of Engineering & Applied Sciences
Department of Electrical and Computer Engineering

Graduate Student Handbook

Professor Marvin Doyley – Department Chair
Professor Michael Huang – Graduate Admissions Committee Chair
Professor Gonzalo Mateos – Graduate Committee Chair

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Overview

Our robust research program touches a wide variety of disciplines including medical imaging, digital audio and music, and quantum optoelectronics. To learn more about the department's current research programs, visit the research page.

Prospective Students
Questions about the ECE graduate program? You may complete this Inquiry Form, contact Michele Foster, Graduate Administrator, at michele.foster@rochester.edu or visit our ECE FAQ page. For general information about being a graduate student at Rochester, visit the graduate studies website.

Incoming Students
Congratulations on being accepted into the electrical and computer engineering graduate program! Be sure to review the incoming graduate student checklist to ensure that you've filled out the appropriate paperwork.

General ECE Information

Hours and University Holidays: The Department of Electrical and Computer Engineering offices are open Monday through Friday, 8:00 a.m. to 4:30 p.m. These hours remain the same during all University breaks, except UR-observed holidays (New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving (2 days; Thursday and Friday), and Christmas Day).

Emergency or Temporary Closings and Other Changes in Class Schedules and University Operations. The University plans to commence and conclude classes on the dates indicated in the academic calendars. But unforeseen circumstances or events may occur that require the University to temporarily close or otherwise adjust its student life, residential housing, class schedules and format, method and location of instruction, educational activities, and operations because of reasons beyond the University's control. For example, such circumstances or events may include but are not limited to inclement weather, the onset of public health crises, being subject to government order(s), significant safety or security concerns, faculty illness, strikes, labor disturbances, sabotage, terrorism, war, riot, civil unrest, fire, flood, earthquake, acts of God, malfunction of University equipment (including computers), cyberattacks, unavailability of particular University facilities occasioned by damage to the premises, repairs or other causes, as well as disruption/unavailability of utilities, labor, energy, materials, transportation, electricity, security, or the internet. If any of these or other unforeseen circumstances or events outside of the University's control occur, the University will respond as necessary and appropriate, and it assumes no liability for any interruption or adjustments made to student life, residential housing, class schedules and format, method and location of instruction, educational activities, and operations caused by these or other unforeseen circumstances or events. And the University shall not be responsible for the refund of any tuition or fees in the event of any such unforeseen circumstances or events, except as may otherwise be expressly provided in the University's Leave of Absence and Withdrawal Policy or its published tuition refund schedule (Payments and Refunds - Office of the Bursar (rochester.edu)).

Location: The Department of Electrical and Computer Engineering offices are located on the University of Rochester River Campus in the Computer Studies Building and the Hopeman Building.

Web Pages

University of Rochester:	http://www.rochester.edu
Hajim School of Engineering & Applied Sciences:	http://www.hajim.rochester.edu
Electrical & Computer Engineering:	http://www.ece.rochester.edu
AS&E Graduate Studies Office:	http://www.rochester.edu/college/gradstudies

Master's Program

Program Requirements

The MS degree requires at least 30 credit hours of graduate 400-leve course work with 16 of these credit hours being in electrical and computer engineering (ECE) course work. Twelve of these 16 credits should be within the selected **Area of Concentration**. Research and reading courses cannot be counted towards the required 16 ECE credit hours.

Concentrations

Each MS candidate, including students who plan to pursue a PhD, must also declare a concentration of study. The areas of concentration are:

- Musical acoustics and signal processing
- Signal/Image processing and Communications
- Biomedical/ultrasound
- VLSI/IC microelectronics and computer design
- Superconducting and solid-state electronics
- Optoelectronics

Each MS candidate must choose one of the following options:

Plan A, Thesis Option (requires 6-10 research credits)

All thesis students must successfully defend a thesis. The defense must be conducted by a committee of no less than two ECE faculty members and one outside faculty member. The thesis defense must be completed by mid-December for fall graduation or by mid-April for spring graduation. Check the graduate calendar for this year's deadlines. If the Research Advisor is from outside of ECE, the committee is required to have two ECE faculty members, one outside faculty member, plus the Research Advisor.

Plan B, Exam Option (0-6 research credits allowed)

All part-time and non-thesis option students must pass a MS exam, which can be a term project, an essay or an oral exam. The exam must be conducted by a committee of no less than two ECE faculty members. The MS exam must be completed by mid-December for fall graduation or by mid-April for spring graduation. Check the graduate calendar for this year's deadlines.

Master's Program of Study

Each full-time master's student must submit a proposed program of study (POS) at the beginning of the second semester. The program of study should be completed and signed by your faculty advisor before submitting to the graduate coordinator for approval. Once approved at the department level it will be to the associate dean.

The POS is expected to form a consistent plan of work to complete the required 30 credit hours. Courses in another department closely related to, but outside the student's major field of interest should not ordinarily exceed 12 hours of credit. The program must include at least 20 credit hours taken at the University of Rochester as a matriculated student in a graduate degree program. Up to 10 credit hours of graduate level credit from an undergraduate-graduate degree program can be included with an approved Transfer Credit form.

UNIVERSITY OF ROCHESTER
ARTS, SCIENCES AND ENGINEERING

Version Original

PROGRAM OF STUDY FOR THE MASTER'S AND/OR PHD DEGREES

Name Jane Doe URID 12345678

Program MS - ECE - Signal & Image Processing Date Jan 2017

☐ PhD

☑ Master's Plan Plan B

INSTRUCTIONS: This program of study must be prepared by the student in consultation with the department. Courses completed should include the grade earned in the course. Courses in progress should be marked with an asterisk (*). Courses taken at other institutions for transfer credit should be listed separately and an official supporting transcript attached, except that if a Master's degree is presented for 30 hours transfer credit, the individual courses need not be listed.

Subject/ Course #	Check if Master's PoS	Grade (if completed)	Descriptive Title		Credit Hours
ECE 447	x	A	Digital Image Processing	(Fall 17)	4
ECE 446	x	A-	Intro Random Processing	(Fall 17)	4
ECE 440	x	A-	Random Processes	(Fall 17)	4
ECE 445	x		Wireless Communications	(Sp18)	4
BME 451	x		Biomedical Ultrasound	(Sp18)	4
BME 451	x		Medical Imag & Implement	(Sp18)	4
ECE 495	x		MS Research in ECE	(Fall18)	6

Remarks

Total Hours (at least 30 credit hours for Master's and 90 credit hours for PhD) 30

APPROVED, Faculty Advisor _____ Date _____

APPROVED, Dean of Graduate Studies _____ Date _____

DISTRIBUTION:
GSO Student File and Department

Rev 10/15

Master's Areas of Concentration and Research

The department's graduate research is broken up into categories, many of which overlap depending on the type of research that the student undertakes.

- **Machine Learning and Artificial Intelligence**
- **Music Acoustics and Signal Processing**
- **Signal/Image Processing and Communications**
- **Circuits and Computer Systems**
- **Novel Computing**
- **Nanoscale Electronics & Photonics**
- **Quantum Engineering**
- **Robotics**

Machine Learning and Artificial Intelligence

The MS concentration in Machine Learning and Artificial Intelligence is designed to equip students with the expertise needed to thrive in one of the most rapidly advancing fields in technology. Machine Learning (ML) and Artificial Intelligence (AI) are transforming industries by enabling computers to learn from data and perform tasks that typically require human intelligence, such as recognizing patterns, making decisions, designing circuits, and understanding natural language. These technologies are integral to innovations across sectors including healthcare, engineering, finance, transportation, and entertainment, driving efficiencies, uncovering new insights, and creating opportunities for enhanced user experiences and improved quality of life.

In this concentration, students will gain a deep understanding of the foundations and practical applications of ML and AI. They will develop proficiency in programming languages such as Python, learn to implement various ML algorithms, and gain experience with AI frameworks like TensorFlow and PyTorch. The curriculum also emphasizes critical skills in data analysis, statistical modeling, and the ethical considerations of AI deployment. Our faculty's unique expertise in audio and music, medical imaging, robotics, networks and graphs, AR/VR, directly translates to an exciting curriculum for students with an electrical engineering background. Through hands-on projects and real-world case studies, students will learn to design, evaluate, and deploy intelligent systems, preparing them to become leaders and innovators in the dynamic field of ML and AI.

Concentration Requirements

One of the following courses:

- ECE 408: The Art of Machine Learning
- ECE 409: Machine Learning

Two of the following courses:

- ECE 403: Advanced Computer Architecture for Machine Learning
- ECE 412: Optimization for Machine Learning

- ECE 477: Computer Audition
- ECE 440: Introduction to Random Processes
- ECE 484: Machine Learning for Medical Imaging
- ECE 442: Network Science Analytics
- ECE 449: Machine Vision

Musical Acoustics and Signal Processing

In this program, students can earn their master's with a concentration in musical acoustics and signal processing in one calendar year. Program instructors include faculty from both the ECE department and the Eastman School of Music.

Non-EE majors would need the following courses which can be found at a Community College:

- Calculus including linear algebra and multi-variable calculus.
- Calculus based Physics including Mechanics and Electricity & Magnetism
- Circuits and Systems (typical sophomore EE course)
- A course in Signals
- A programming course in C/C++ or other formal

Students enrolled in this program are encouraged to participate in one of the many ongoing research projects in the Music Research Laboratory, including projects on:

- Internet-enabled music telepresence and immersive audio environments
- Musical source separation and automated music transcription
- Physical modeling musical sound synthesis
- Music representations
- Audio watermarking
- Quantitative studies of musical timbre
- Audio embedded music metadata

Students can also participate in research in music perception and cognition, and music and language being done in other allied laboratories.

Musical Acoustics and Signal Processing Concentration Requirements

- ECE 429: Audio Electronics
- ECE 433: Musical Acoustics
- ECE 439: Spatial Audio
- ECE 470: Digital Audio Effects
- ECE 472: Audio Signal Processing
- ECE 475: Audio Software Design I
- ECE 476: Audio Software Design II
- ECE 477: Computer Audition
- ECE 478: Revolutions in Sound
- ECE 480: Advanced Audio Amplifier Design

Signal and Image Processing and Communications

Students in this program can participate in a wide range of research including:

- Signal research on:
    - Wide-band radar and sonar systems design

    - Digital image and video processing
    - Very low bitrate video compression
    - Medical image processing
- Communications research on:
    - Frequency hopping codes for multiple-access-spread-spectrum communications, designed to minimize interference in radar and sonar systems
- Digital image processing research on:
    - Image enhancement and restoration
    - Image segmentation/recognition
    - Processing of magnetic resonance images
- Digital video processing research on:
    - 2-D and 3-D motion estimation techniques
    - Deformable motion analysis
    - Stereoscopic image analysis
    - Standards conversion and high-resolution image reconstruction
    - Object-based methods for very low bitrate video compression
- Biomedical signal processing research on:
    - Spectral analysis in one-, two-, and three-dimensional spaces
    - Analysis and algorithms for computed tomography
    - Inverse scattering techniques for imaging tissue characterization

Signal and Image Processing Concentration Requirements

ECE 446: Digital Signal Processing
Two of the following courses:

- ECE 408: The Art of Machine Learning
- ECE 410: Introduction to Augmented and Virtual Reality
- ECE 411: Special Topics in Augmented and Virtual Reality
- ECE 433: Probabilistic Models for Inference and Estimation
- ECE 440: Random Processes
- ECE 441: Detection and Estimation Theory
- ECE 447: Digital Image Processing
- ECE 450: Information Theory
- ECE 457: Digital Video Processing
- ECE 477: Computer Audition
- ECE 449: Machine Vision

Communications Concentration Requirements

ECE 444: Digital Communications or ECE 445: Wireless Communications
One of the following courses:

- ECE 440: Random Processes
- ECE 441: Detection and Estimation Theory
- ECE 444: Digital Communications
- ECE 446: Digital Signal Processing
- ECE 448: Wireless Sensor Networks
- ECE 450: Information Theory
- CSC 457: Computer Networks

Biomedical Ultrasound and Biomedical Engineering

High-frequency sound (ultrasound) is used in many areas of medicine to obtain images of soft organs in the body. High-intensity ultrasound is used to destroy kidney and gallstones without surgery (lithotripsy).

Students in this program will conduct scientific investigations that focus on the interactions of ultrasonic energy with biological materials ranging from heart and liver tissues to bones and gallstones. Students may also conduct research on the applications of ultrasonic contrast-producing agents similar to radiological contrast and tracer techniques. The results from these efforts are used to improve or extend clinical applications of ultrasonic techniques, both in diagnosing diseases of the heart and liver, and in therapeutic users such as lithotripsy. This work is also used to set standards for exposure of patients during examination and to improve the application of high-intensity sound for therapy.

Biomedical Ultrasound and Biomedical Engineering Concentration Requirements

Three of the following courses:

- ECE 432: Acoustic Waves
- ECE 452: Medical Imaging
- ECE 446: Digital Signal Processing
- ECE 447: Digital Image Processing
- BME 451: Biomedical Ultrasound
- ECE 453/BME 453: Ultrasound Imaging

Circuits and Computer Systems

VLSI/IC Microelectronics and Computer Design

Students in this program work in a variety of VLSI/IC microelectronics and computer design research areas. Some of the current research being conducted here at Rochester includes:

- Research in VLSI and CAE to address topics in integrated circuit design methodologies and automation.
- Specific system-oriented research including an analytical model for multi-access protocols with prioritized messages and distributed control architecture.
- Testability studies that explore operational parallelism in any testing process to determine the set of automated test procedures which minimizes the silicon area consumed by the built-in self-test structures.
- Applying VLSI design and analysis techniques to develop ultrafast superconducting digital integrated circuits.
- Designing and analyzing high performance VLSI-based digital and analog integrated circuits and their systems. Specifically, speed, area, and power dissipation tradeoffs are investigated in terms of application-specific constraints and their fundamental circuit level limitations.

VLSI/IC Microelectronics Design Concentration Requirements

Three of the following courses:

- ECE 429: Audio Electronics
- ECE 461: Introduction to VLSI
- ECE 466: RF and Microwave Integrated Circuits
- ECE 468: Advanced Analog CMOS Circuits and Systems
- ECE 469: High Speed Integrated Electronics

Computer Design and Computer Engineering Concentration Requirements
ECE 401: Advanced Computer Architecture
Two of the following courses:

- ECE 400: Computer Organization
- ECE 401: Advanced Computer Architecture
- ECE 403: Advanced Computer Architecture for Machine Learning
- ECE 404: Microprocessor Architecture
- ECE 405: Ising Machines: Principles and Practices
- ECE 408: The Art of Machine Lear
- ECE 409: Machine Learning
- ECE 413: Introduction to Hardware Security
- CSC 455: Software Analysis and Improvement
- CSC 456: Operating Systems
- CSC 458: Parallel and Distributed Systems
- ECE 461: Introduction to VLSI

Novel Computing

The fields of future petascale engineering and quantum information science are at the center of the XXI century "beyond CMOS technological transformation, expected to have an impossible to overestimate impact on society and national security. They reside at the core of enabling technologies ranging from generative artificial intelligence, massive data storage centers to networks of quantum computers for multi-party processing.

The primary goal of the "Novel Computing" MS concentration is parallel to the DISCoVER: Design and Integration of Superconducting Computation for Ventures beyond Exascale Realization (a 7-year Expedition Project funded by NSF), i.e., to explore novel ways to harness superconductivity for petascale computing. DISCoVER will accomplish these objectives through a compelling combination of technological advances, novel circuits, and innovative architectures, resulting in the demonstration of a superconductor system of cryogenic computing cores. This system will consist of a 32-bit superconducting CPU integrated with a superconductor neural network accelerator and a superconductor Ising machine solver. Our goal is to achieve a performance-energy efficiency gain of more than 100x at the complete system level as compared to deeply-scaled CMOS–a remarkable leap forward in technological, energy-efficient computing.

The concentration is aimed at the best undergraduate students in such areas as electrical and computer engineering, physics, materials science, computer science, and more. Students in the program will graduate with the unique skills and knowledge needed to become leaders in the emerging future engineering hardware development. The degree will open wide-range perspectives for employment in high-tech industry and/or will be a steppingstone to further graduate education. Summer internships at participating DISCoVER research groups are part of the program.

Concentration Requirements

These three courses:

- ECE 423: Semiconductor Devices
- ECE 425: Superconductivity and the Josephson Effect (new course)
- ECE 427: Superconductor Electronics (new course)

Plus, any of others below

- ECE 420: Introduction to Quantum Engineering Science and Engineering E
- ECE 422: Nanoelectronic Devices
- ECE 461: Intro to VLSI
- ECE 469: High-Speed Integrated Electronics
- ECE 520: Spin-Based Electronics

Nanoscale Electronics & Photonics

Nanoscale Devices:
In a new and ever-changing landscape of electronics needs, there has been a strong focus to work with deeply scaled nanoelectronic transistors and to go beyond conventional Si-based transistors entirely. New technologies such as spintronics, 2D electronics, phase-change electronics, neuromorphic electronics, superconducting electronics and topological electronics are becoming more important in defining what the next 50 years of electronics looks like from the device level up.

Students in this program work in a variety of next generation nanoelectronic device research areas. Some of the current research being conducted here at Rochester includes:

- Nanoelectronic devices with 2D van der Waals-bonded materials (graphene, transition metal dichalcogenides, phosphorene, etc…).
- Heteroepitaxial growth of new electronic materials, or heteroepitaxial assembly of 2D vdW electronic materials.
- Novel spintronic and magnetic devices with unconventional magnetic materials or unconventional device constructs.
- Topological electronic devices implemented with quantum electronic materials.
- Implementing new superconducting devices, along with the design/fabrication/testing of superconducting digital integrated circuits. Applications may include quantum computing or ultra-high speed digital electronics.
- Using picosecond electrical and optical pulses to probe the transient response of semiconducting and superconducting devices, such as Metal-Semiconductor-Metal (MSM) photodiodes and tunnel junctions.

Nanoelectronic Devices Concentration Requirements:

- ECE 423: Semiconductor Devices
- ECE 422: Nanoelectronic Devices
- ECE 436: Nanophotonic and Nanomechanical Devices
- ECE 469: High Speed Electronics

Photonics:
Information processing with optical pulses allows for higher data rates than electronic signals. Optoelectronics research is focused on obtaining a detailed understanding of ultrafast phenomena and ultrafast nonlinearities in semiconductors and high-temperature superconductors, and at using silicon quantum dots and nanometer-size objects in optoelectronics and biosensing.

Students in this program work in a variety of optoelectronic research areas. Some of the current research being conducted here at Rochester includes:

- Using laser technology, solid-state physics, materials science, and device physics and engineering to design novel optoelectronic devices.
- Studying electron and hole thermalization and recombination in semiconductors and semiconductor quantum wells, and the optoelectronic properties of porous silicon, which unlike crystalline silicon emits light efficiently at room temperature.
- Determining response times using laser processing of Y-Ba-Cu-O epitaxial thin films into oxygen-rich (superconducting) and oxygen-poor (semiconducting) regions, together with pump-probe femtosecond reflectivity measurements.

Photonics Concentration Requirements:

Three of the following courses:

- ECE 421 (OPT 421): Optical Properties of Materials
- ECE 422: Nanoelectronic Devices
- ECE 423: Semiconductor Devices
- ECE 426 (OPT 428): Waveguides and Optoelectronic Devices
- ECE 436: Nanophotonic and Nanomechanical Devices

Quantum Engineering:

The fields of quantum engineering and quantum information science are on the verge of disruptive breakthroughs, with a potential for having an impossible to overestimate impact on society and national security. They reside at the core of all these breakthroughs as an enabling technology by connecting networks of quantum computers for multi-party processing or enabling communications with absolute security rooted in the laws of physics.

The concentration brings together an interdisciplinary team to solve important technological problems related to quantum information processing with a focus on:

- Socially important issues such as rapidly growing presence and overall importance of computers and computing in our present daily lives
- Data/information security
- Economic and social impact of seemingly unlimited capabilities of data (often personal) processing and storage, as well as how the latter is going to change our perception as human beings, when augmented reality and virtual reality will become our “daily” reality.

Quantum Engineering Concentration Requirements:

- ECE4xx Introduction to Quantum Engineering (new course)
- ECE423 Semiconductor Devices
- ECE425 Superconducting Electronics
- ECE436 Nanophotonics
- ECE454 Quantum Information Processing (new course)
- ECE461 Intro to VLSI
- ECE4xx Quantum electronic devices and materials (new course)
- ECE469 High-Speed Integrated Electronics
- ECE520 Spin-Based Electronics

Robotics

Robotics is a field of engineering that covers many different topics from mechanism design and embedded systems to artificial intelligence and machine learning. Roboticists draw their talents from and from many fields including electrical engineering, computer engineering, computer science, mechanical engineering

and other adjacent fields and often work closely with engineers and researchers from these disciplines. The development and deployment of intelligent robots have the promise to transform how we transport materials and people, grow food and manufacture goods, diagnose and treat illnesses, and explore this and other planets.
Students in this program will develop an understanding of systems, models, and algorithms for how robots make decisions about how to interact with the physical world from sensor information and prior knowledge. Students may also conduct fundamental research in theoretical or experimental robotics to improve the performance of such systems in a wide range of applications. Students will additionally develop practical skills such as robotics software development and physical experimentation techniques through hands-on laboratory exercises and research activities.

Students in this program may participate in a wide range of research including

- Guidance, navigation, and control of unmanned ground vehicles
- Symbol grounding for human-robot interaction and teaming
- Reinforcement learning for underactuated robot control
- Perception for robot intelligence
- Control systems for robotically assisted medical imaging

Robotics Concentration Requirements:
One of the following courses:

- ECE 417: Robot Motion Planning and Manipulation
- ECE 418: Mobile Robot Estimation, Mapping, Navigation, and Interaction

Two of the following courses:

- ECE 409: Machine Learning
- ECE 440: Intro to Random Processes
- ECE 443: Probabilistic Models for Inference and Estimation
- ECE 449: Machine Vision

Teaching Assistant Requirement – MS

There is not a TA requirement for the Master's program in ECE.

There are opportunities to be assigned as a TA position for compensation. Being assigned as a TA is considered an Add-on employment position and UR Employment verification guidelines will be followed. Compensation for TA add-on hire is paid by the semester at the established MS TA hire pay-rate. See the Graduate Administrator for details.

Research Assistant Requirement – MS

There is not a RA requirement for the Master's program in ECE. Most MS students do research for credit.

There are opportunities to be hired in a RA position for compensation. Being hired in a RA is considered an Add-on employment position and UR Employment verification guidelines will be followed. Compensation for RA add-on hire is paid as an hourly-based position within a pay-range established by Student Employment guidelines. See the Graduate Administrator for details.

PhD Program

The PhD degree requires 90 credit hours of graduate study, 60 of these being beyond a master's degree.

All PhD students must take and pass 16 credits of ECE graduate-level coursework. At least two ECE graduate-level courses from their academic/research concentration and at least one ECE graduate-level course from each of the other two concentration areas. These four ECE courses must be taken during the first year of study.

If a PhD student wishes to pursue a MS in electrical engineering, **two additional courses** will be required to complete a total of 24 course credits toward the 30 required for the MS (non-thesis) degree. At least 16 of these course credits must be in ECE courses. The Comprehensive Examination will complete the MS Final Exam requirement for the MS degree.

Teaching Assistant Requirement - PhD

All graduate students matriculated for the PhD degree are required to perform a certain amount of teaching assistance as part of their education. Teaching experience deepens and enriches a student's understanding of the discipline and provides invaluable professional training and is, therefore, considered to be a vital component of any PhD program. T**he ECE department requires two semesters of TA experience**.

There are opportunities to be assigned as a TA position beyond the two-semester requirement. Being assigned as a TA after the requirement is fulfilled is considered an **Add-on** employment position and UR Employment verification guidelines will be followed. Compensation for TA add-on hire is paid by the semester at the established TA hire pay-rate. See the Graduate Coordinator for details.

Research Assistant - PhD

All PhD graduate students in ECE receive a fellowship/stipend or assistantship from the University. These appointments are for positions in which the graduate student is conducting duties required by their academic program. These appointments may also be used when graduate students are receiving payments for living expenses with no expectation for service (e.g. Sproull Fellowships). The University considers these appointments educational, and the type of appointment (Grad Fellowship/Stipend vs. Grad Assistantship) depends on the source of the funding for the position. This stipend is paid by the Advisor as long as sufficient progress is being made toward the degree.

Areas of Concentration and Research

The ECE Department's PhD graduate research program will be partitioned into five main areas of concentration and research:

1. ***Signals, Communication, and Imaging:*** Signal and Image Processing, Communications, Medical Imaging, Machine Learning
2. ***Integrated Electronics and Computer Engineering*:** VLSI/IC Microelectronics, Computer Design/Architecture, Hardware Security, Machine Learning
3. ***Physical Electronics, Electromagnetism, and Quantum Engineering*:** Superconductivity and Solid-State Electronics, Optoelectronics, Integrated Photonics, Microelectromechanics and Electrostatics
4. ***Audio and Acoustics*:** Music Acoustics and Signal Processing, Acoustic Waves, Audio Electronics and Software Design
5. ***Robotics:*** Motion Planning, Navigation, Control, Estimation, Perception, Artificial Intellegence

Students will take four graduate-level classes in their chosen concentration area and at least two graduate-level courses from one of the other concentration areas. The specific courses will be selected by each individual student and their research advisor.

***Signals, Communication, and Imaging:* Signal and Image Processing, Communications, Medical Imaging, Machine Learning**

- Signal research on:
  - Wide-band radar and sonar systems design
  - Digital image and video processing
  - Very low bitrate video compression
  - Medical image processing
- Communications research on:
  - Frequency hopping codes for multiple-access-spread-spectrum communications, designed to minimize interference in radar and sonar systems
- Digital image processing research on:
  - Image enhancement and restoration
  - Image segmentation/recognition
  - Processing of magnetic resonance images
- Digital video processing research on:
  - 2-D and 3-D motion estimation techniques
  - Deformable motion analysis
  - Stereoscopic image analysis
  - Standards conversion and high-resolution image reconstruction
  - Object-based methods for very low bitrate video compression
- Biomedical signal processing research on:
  - Spectral analysis in one-, two-, and three-dimensional spaces
  - Analysis and algorithms for computed tomography
  - Inverse scattering techniques for imaging tissue characterization

***Integrated Electronics and Computer Engineering*: VLSI/IC Microelectronics, Computer Design/Architecture**

Students in this program work in a variety of VLSI/IC microelectronics and computer design research areas. Some of the current research being conducted here at Rochester includes:

- Research in VLSI and CAE to address topics in integrated circuit design methodologies and automation.
- Specific system-oriented research including an analytical model for multi-access protocols with prioritized messages and distributed control architecture.
- Testability studies that explore operational parallelism in any testing process to determine the set of automated test procedures which minimizes the silicon area consumed by the built-in self-test structures.
- Applying VLSI design and analysis techniques to develop ultrafast superconducting digital integrated circuits.
- Designing and analyzing high performance VLSI-based digital and analog integrated circuits and their systems. Specifically, speed, area, and power dissipation tradeoffs are investigated in terms of application-specific constraints and their fundamental circuit level limitations.

***Physical Electronics, Electromagnetism, and Quantum Engineering*: Superconductivity and Solid-State Electronics, Optoelectronics, Integrated Photonics, Microelectromechanics and Electrostatics**

In a new and ever-changing landscape of electronics needs, there has been a strong focus to work with deeply scaled nanoelectronic transistors and to go beyond conventional Si-based transistors entirely. New technologies such as spintronics, 2D electronics, phase-change electronics, neuromorphic electronics, superconducting electronics and topological electronics are becoming more important in defining what the next 50 years of electronics looks like from the device level up.

Students in this program work in a variety of next generation nanoelectronic device research areas. Some of the current research being conducted here at Rochester includes:

- Nanoelectronic devices with 2D van der Waals-bonded materials (graphene, transition metal dichalcogenides, phosphorene, etc…).
- Heteroepitaxial growth of new electronic materials, or heteroepitaxial assembly of 2D vdW electronic materials.
- Novel spintronic and magnetic devices with unconventional magnetic materials or unconventional device constructs.
- Topological electronic devices implemented with quantum electronic materials.
- Implementing new superconducting devices, along with the design/fabrication/testing of superconducting digital integrated circuits. Applications may include quantum computing or ultra-high speed digital electronics.

- Using picosecond electrical and optical pulses to probe the transient response of semiconducting and superconducting devices, such as Metal-Semiconductor-Metal (MSM) photodiodes and tunnel junctions.

Information processing with optical pulses allows for high data rates than electronic signals. Optoelectronics research is focused on obtaining a detailed understanding of ultrafast phenomena and ultrafast nonlinearities in semiconductors and high-temperature superconductors, and at using silicon quantum dots and nanometer-size objects in optoelectronics and biosensing.

Students in this program work in a variety of optoelectronic research areas. Some of the current research being conducted here at Rochester includes:

- Using laser technology, solid-state physics, materials science, and device physics and engineering to design novel optoelectronic devices.
- Studying electron and hole thermalization and recombination in semiconductors and semiconductor quantum wells, and the optoelectronic properties of porous silicon, which unlike crystalline silicon emits light efficiently at room temperature.

Determining response times using laser processing of Y-Ba-Cu-O epitaxial thin films into oxygen-rich (superconducting) and oxygen-poor (semiconducting) regions, together with pump-probe femtosecond reflectivity measurements.

***Audio and Acoustics*: Music Acoustics and Signal Processing, Acoustic Waves, Audio Electronics and Software Design**

Students in this program work in a variety of acoustic research areas. Some of the current research topics here at Rochester include:

- Acoustic wave equation
- Plane, spherical, and cylindrical wave propagation
- Reflection and transmission at boundaries
- Normal modes
- Absorption and dispersion
- Radiation from points, spheres, cylinders, pistons, and arrays
- Diffraction
- Nonlinear acoustics
- Music Acoustics
    - Internet-enabled music telepresence and immersive audio environments
    - Musical source separation and automated music transcription
    - Physical modeling musical sound synthesis
    - Music representations
    - Audio watermarking
    - Quantitative studies of musical timbre

Robotics: **Motion Planning, Navigation, Control, Estimation, Perception**

Students in this program will develop an understanding of systems, models, and algorithms for how robots make decisions about how to interact with the physical world from sensor information and prior knowledge. Students may also conduct fundamental research in theoretical or experimental robotics to improve the performance of such systems in a wide range of applications. Students will additionally develop practical skills such as robotics software development and physical experimentation techniques through hands-on laboratory exercises and research activities.

Students in this program may participate in a wide range of research including

- Guidance, navigation, and control of unmanned ground vehicles
- Symbol grounding for human-robot interaction and teaming
- Reinforcement learning for underactuated robot control
- Perception for robot intelligence
- Control systems for robotically assisted medical imaging

Comprehensive First-year Exam Requirements

The Comprehensive Examination, to be completed by the end of the first year of study, is required for continuation in the PhD program. Students may petition to extend the time for completing these requirements. Part-time students and those with a non-ECE background may need additional time.

The ECE Department's PhD graduate research program will be partitioned into five main areas of concentration and research:

1. ***Signals, Communication, and Imaging:*** Signal and Image Processing, Communications, Medical Imaging, Machine Learning
2. ***Integrated Electronics and Computer Engineering*****:** VLSI/IC Microelectronics, Computer Design/Architecture, Hardware Security
3. ***Physical Electronics, Electromagnetism, and Quantum Engineering*****:** Superconductivity and Solid-State Electronics, Optoelectronics, Integrated Photonics, Microelectromechanics and Electrostatics
4. ***Audio and Acoustics*****:** Music Acoustics and Signal Processing, Acoustic Waves, Audio Electronics and Software Design
5. ***Robotics:*** Motion Planning, Navigation, Control, Estimation, Perception

All first year PhD students must satisfy the following requirements for continuation in the PhD program:

1. **4+2 Course Requirement**: Upon joining the PhD program, a student should claim one of the above areas of concentration. A detailed list of courses falling under each area of concentration will be posted on the ECE Department's website; the list is also included below for convenience. All PhD students must take and pass 6 graduate level courses (400-level) during their first year of study. To satisfy the area depth requirement, 4 of these courses should be from their chosen area of concentration. To comply with the breadth of knowledge requirement, the 2 other courses should be selected from 2 different (out of the remaining 4) external areas of concentration. Some courses may be listed in more than one area, and these courses may be used to satisfy the breadth of knowledge requirement. The specific courses are to be selected by the students in agreement with their research advisors.

Students with no prior ECE background at the undergraduate or MS level should take the new entry-level graduate course ECE 402 - Electrical Engineering Fundamentals in the Fall of their first year of study. This 4-credit course *will count as one of the two courses required outside their area of concentration*. By inspecting the students' transcripts, the Graduate Admissions Committee can indicate who should take this course. Students with an MSc in EE degree will be exempt from this leveling requirement.

Under specific circumstances requiring approval from the student's PhD advisor and the ECE Graduate Committee, relevant courses from other programs (e.g., Mathematics or Computer Science) could be considered to satisfy the 4+2 Course Requirement. Likewise, if a core course deemed to be important to the student's training is not offered during their first year of studies (some ECE graduate courses are offered every other year), the student could petition to take it during their second year.

UR MS EE students that transition to the PhD program will have already taken 6 of our courses and should be exempt from additional coursework requirements. Students coming from other UR MS degree programs, like Physics and Optics, may have taken some of these courses but would most likely need to take at least a few more. For these cases (or if an UR MS EE student decides to change their area of concentration), additional course requirements should be set on a case- by-case basis. Incoming PhD students with an MS degree from other schools should complete the 4+2 Course Requirement outlined above. In very special circumstances, the Graduate Committee can approve a thoroughly justified petition to reduce the course load by a maximum of two courses on a case-by-case basis. All PhD students should take and pass the PhD Comprehensive Exam by the end of their first year of studies.

2. Comprehensive Exam: The PhD Comprehensive Exam evaluates the student's depth of knowledge and research capability in the chosen area of concentration, as well as their writing, communication, and presentation skills.

Each year, ~2 faculty per area of concentration will take on the responsibility to serve in the examination committees of all the students in that area (nominally, 2-4 students or even less). Maintaining a fixed committee to evaluate all exams in that particular year and area has the advantage of providing more consistent evaluation criteria across the student cohort. *The student's PhD advisor will be included in the committee*. This would allow the advisor to provide general recommendations to the student about the exam.

The PhD Comprehensive Exam will consist of two intertwined parts: (i) submission of a written report; and (ii) an oral presentation to the exam committee followed by questioning.

Written Exam: The written exam requires the student to submit a report. The purpose of the written report is to assess a student's readiness and potential for PhD-caliber research. The report should demonstrate that the student has sufficient depth of knowledge in their intended area of concentration and research. The student's ability to understand and think critically about their research topic will be assessed, as well as their ability to communicate clearly and effectively in written English.

In terms of scope, the written report should be an in-depth review/study of a research paper/project assigned by the area exam committee. The choice of format (assigning papers to critique versus applied projects for the students to work on) is left to the discretion of the area exam committees. The same format should be adopted for all students in the concentration area any given year, and the final deliverable should always be a written report. The choice of the paper assigned can be informed by e.g., keywords defining subareas of interest submitted by the student or a recommendation made by the student's PhD advisor (for instance, so that the time spent working on the exam also contributes to the student's own research in their lab). In the submitted report, the student should provide a critical evaluation of the paper by means of thorough explanations of the key concepts and trade-offs, positioning in the context of related work (with adequate references) and provide insight into promising areas of future work (especially if the paper represents the state-of-the-art). The area exam committee members could provide additional specific information and guidelines of what is expected of the students when preparing the report.

As far as the format is concerned, the report should be submitted as a single PDF file not exceeding 8 pages and using the format and style guidelines for submission to IEEE Transaction journals. Students should be encouraged to use LaTeX while using a specific template they are likely to encounter down the road. The written material in the report should be independently generated by the student. The same applies to uncited figures, tables and code, whose original preparation is encouraged.

Regarding timeline, the project or paper assignment should be made by *~May 15* on the student's first year of PhD studies. The report should be submitted by the students by *~June 15*. With these revised dates, the written exam should not conflict with Spring semester coursework.

Oral Exam: The oral examination requires the student to prepare slides and give a short presentation explaining the contents of the written report to the members of the concentration area committee. A Q&A session will follow, providing a second instance to gauge whether the student possesses sufficient depth of knowledge in their intended area of concentration and research. Specific to the oral examination, the student's aptitudes to present and communicate research orally will be assessed, as well their ability to understand and answer questions effectively.

The oral component is conducted as a closed-door examination. The duration of the presentation should be ~30 minutes, followed by no more than 30 additional minutes of Q&A. The questions posed by the committee will be mostly about the contents of the written report and the ensuing presentation. Optionally, the committee can pose additional questions about ECE fundamentals within the area of concentration, including material from the first-year graduate courses taken by the student.

The oral examinations will be scheduled for the week of *~July 1st*. This should give enough time for the students to work on their presentations after submitting their reports, and for the committee members to read and grade the written exams.

In making the final PhD Comprehensive Exam Pass/Fail recommendation, the committee members will vote based on the student's performance in both parts of the examination (perhaps also considering the grades in their first-year courses and the PhD advisor's general appraisal of the student). The committee will notify the student of the result of the exam no later than a couple days after all exams are concluded, via an email copied to the Graduate Coordinator. Students have two chances to pass the PhD Comprehensive Exam (the second attempt can be scheduled sometime around *~August 15*, given the student plenty of time to incorporate the feedback received from the committee). A student that fails the exam twice will be removed from the PhD program, possibly graduating with an MSc degree given the credits gained from the 6 first-year courses plus additional research credits obtained during the Summer.

PhD Annual Self-Evaluation

The Office of Graduate Education and Postdoctoral Affairs is requiring that all departments in AS&E conduct an annual evaluation of their PhD students in conjunction with their graduate program. Annual evaluations are a key practice for your professional development. It provides an opportunity to track progress and build your portfolio, identify areas for improvement, and celebrate success. By completing a yearly evaluation, you have an opportunity to receive feedback from your advisor and/or department and to clarify goals and expectations with them, reflect on what you have already accomplished as well as to set goals for the future.

1. Student Self-Assessment: Each assessment begins with the student's completion of the self-evaluation form, which is emailed to all PhD students by the Graduate Administrator. This self-evaluation asks the student to describe their activities and self-assess their performance in five different set of program outcomes (i.e. coursework, research, teaching, and professionalization activities undertaken during the past year). The student then emails their completed self-evaluation to their primary advisor for review. **Recommended due date of July 31**.

2. Advisor Review and Meeting: The advisor reviews the self-evaluation and the provides feedback to the student. Ideally, the student and advisor (or thesis committee) should meet to discuss the self-evaluation, goals for the next year, and any areas for improvement. The advisor will then provide written comments in the form, outlining (i) their assessment of the student's progress towards degree completion, and (ii) recommendations for the coming year. Student's will then have an opportunity to respond to the advisor's comments before the advisor forwards the review to the Graduate Administrator (Michele Foster) to review with the Director of Graduate Studies (Gonzalo Mateos). **Recommended due date of August 15**.

3. Graduate Administrator & Director of Graduate Studies: Reviews the completed evaluations of all students and provides comments on any students who is experiencing difficulties maintaining satisfactory progress. The Graduate Administrator tracks the progress. The Director of Graduate Studies will recommend problematic evaluations be forwarded for review by the ASE Dean of Graduate Study. Please ensure this is completed by **August 31**.

PhD Program of Study Policy

At least 90 credit hours of study beyond the bachelor's degree or 60 hours beyond an acceptable master's degree are required. The associate dean of graduate studies may approve, for students who do not present the master's degree, up to 30 credit hours of acceptable graduate work taken at this or another university toward the requirements for the doctoral degree (see section on *Transfer Credit*).

A tentative program of study leading to the degree of Doctor of Philosophy must be prepared by the student in consultation with his or her advisor. This program must include the following a list of those courses for which the student must receive graduate credit. Name of the research advisor.

The program of study must be approved by the department chair/program director or a designated representative and then transmitted to the associate dean of graduate studies for approval. Changes in a student's program are made by the same procedure. The program of study will constitute the formal requirements that must be met by the student before completion of work for the degree.

UNIVERSITY OF ROCHESTER
ARTS, SCIENCES AND ENGINEERING

Version Original

PROGRAM OF STUDY FOR THE MASTER'S AND/OR PHD DEGREES

Name John Electric URID 1234567

Program Electrical and Computer Engineering Date 2/19/2018

☑ PhD

☐ Master's Plan

INSTRUCTIONS: This program of study must be prepared by the student in consultation with the department. Courses completed should include the grade earned in the course. Courses in progress should be marked with an asterisk (*). Courses taken at other institutions for transfer credit should be listed separately and an official supporting transcript attached, except that if a Master's degree is presented for 30 hours transfer credit, the individual courses need not be listed.

Subject/ Course #	Check if Master's PoS	Grade (if completed)	Descriptive Title	Credit Hours
ECE 457		A	DIGITAL VIDEO PROCESSING	4
ECE 428		A	RADIATION & DETECTORS	4
ECE 440		A	INTRO TO RANDOM PROCESSES	4
ECE 409		A	MACHINE LEARNING	4
CSC 576		A	ADV MACHINE LEARNING & OPTIM	4
ECE 595		*	PHD RESEARCH IN ECE	70

Total Hours (at least 30 credit hours for Master's and 90 credit hours for PhD) 90

Remarks

☐ Check here to verify that any 200 level courses on this Program of Study are advanced in content, rigor, and requirements.

APPROVED, Faculty Advisor Michele M. Foster Date 2/19/2018

APPROVED, Dean of Graduate Studies _____ Date _____

DISTRIBUTION:
GSO Student File and Department

Rev 5/16

PhD Qualifyer/Proposal Examination

All doctoral students must pass a PhD qualifying examination and submit a written PhD thesis proposal in their third to fourth year of full-time graduate study.

The proposal document has no formal formatting requirement but we recommend following the formatting instructions in the Manual for PhD Students: Formatting the Thesis and Preparing for the Defense.

The committee for the proposal examination for the PhD degree is approved by the University dean of graduate studies on the advice of the appropriate associate dean of graduate studies. The committee shall consist of:

- At least two current full-time tenure-track members with the rank of assistant professor or higher who hold their primary appointments in the department offering the degree program or are among the core faculty defined for an interdisciplinary PhD program in the role of “inside members.”
- The dissertation advisor or supervisor can have a primary or secondary appointment in the candidate’s program department and must be present for the examination.
- At least one current full-time faculty member at assistant professor rank or higher from outside the student’s department can act as an “outside reader.”
- A committee made up of faculty members whose primary appointments are all in the same department will not be permitted.
- Requests for non-standard committee members must be done by Petition to the Dean. Please see the Graduate Coordinator for this request.

Students who pass the PhD qualifying examination will get thesis research assistance from the Faculty Thesis Advisory Committee. The committee meets with the student at least once each year.

PhD Thesis Defense Examination

Before you can start your thesis you must:

- Complete all courses, exams, and research requirements
- Meet with your committee to ensure that everyone agrees that the work is ready to defend
- Decide on a date for the defense
- Inform your graduate administrator that you have started the process to prepare for your defense

Nominate a Faculty Member to Serve as Chair for Your Defense

A chair is appointed for each PhD oral defense to monitor and promote fairness and rigor in the conduct of the defense. To help eliminate pre-established judgments on the candidate's work, the chair should be from a different program/department than the student. For more information about chair responsibilities, read the instructions for the chair.

You must identify a faculty member to serve as chair for your defense. The chair must be:

- A current full-time faculty member at assistant professor rank or higher
- Outside the department offering the degree program, or outside your advisor's department (interdisciplinary degree programs only)
- Someone who has not had prior involvement in your research

The selection of the chair is subject to the approval of the department/program, the dean of graduate studies in Arts, Sciences and Engineering, and the University dean of graduate studies.

The chair must be physically present during the entire defense, including the public oral presentation (if applicable) and the questioning session. The chair is welcome to read and comment on the dissertation and/or the defense presentation, but this is not required. The chair does not need to be an expert in your research area. It is your responsibility to get a copy of the final dissertation to the chair at least one week prior to the defense.

Selecting a Defense Date

You should begin scheduling the actual defense date **three months in advance** to ensure that your advisor, committee members, and chair are able to be present and that rooms are available on the date and time selected.

Defenses can be held on any day the University's Graduate Studies Office is open (not weekends, evenings, holidays, or the days between Christmas and New Year's). Check the academic calendar for important dates and deadlines.

Use the PhD date calculator to determine the deadline dates for getting your paperwork to the Graduate Studies Office and department committee.

When all committee members and your chair agree to a specific date and time for the defense, inform your graduate administrator as soon as you possibly can, but no later than **six weeks prior to your defense date**. Your graduate administrator will advise you of any program-specific requirements for the defense as well as work with you to prepare for your thesis defense. They will also help you determine who will schedule the room for your thesis defense.

You should provide your committee members **at least two weeks** to read and comment on your dissertation before the date you need to register your dissertation.

Participating Via Video Conferencing

While you, your advisor, and the chair must all be physically present in the room for the defense, other committee members are allowed to participate in the defense remotely via Skype or other video conferencing technology so long as all committee members agree to the arrangement. This must also be

approved by the AS&E dean of graduate studies and the University dean of graduate studies before the dissertation is registered for defense.

Someone other than you and your committee must handle the IT setup and be on standby for any problems. If anyone involved finds that remote participation is interfering with the defense, he or she can request that the defense be rescheduled.

Dissertation Writing and Guidelines

The Preparing Your Thesis manual is a great resource to help you bring your dissertation up to the required standard of organization, appearance, and format for the University of Rochester. Before preparing the defense copy of your dissertation, check the contents of the manual carefully to help avoid mistakes that can be time-consuming and costly to correct.

Registering Your Dissertation for the Final Oral Exam

In order to register your dissertation, you or your graduate administrator will need to create a record on the Graduate Studies PhD Completion website. This record will include:

- Degree information
- Past degrees
- Contact information
- The defense version of your dissertation as a PDF
- Other relevant documents

The version of your dissertation attached to your online record is considered the registration copy.

When your PhD completion record is finalized, committee members will receive emails with links to access your record and approve your dissertation to progress to defense. You'll need to provide copies of the dissertation identical to the registration copy to all members of your committee, including the chair, at least two weeks before the record is finalized. Everyone but the chair is required to comment or sign off on the dissertation before it is submitted.

There may be deadlines for registering your dissertation specific to your program. Consult with your graduate administrator to ascertain those deadlines and follow them carefully.

After all committee members have provided their approval, your thesis will be reviewed by your faculty director/department chair, the AS&E dean of dean of graduate studies, and the office of the University dean of graduate studies. When all these officials have approved your committee and dissertation for defense, your dissertation is considered registered. You will be able to track these approvals in your online record and will receive a confirmation email when approvals are complete.

The Graduate Studies Office and the AS&E dean of graduate studies, as well as the University Graduate Studies Office, may make corrections to the PDF of your dissertation. This annotated copy of your dissertation, along with the original version, will be stored in the PhD completion website. You are not allowed to distribute updated versions of your dissertation prior to the defense, but be sure to incorporate any corrections before uploading your final dissertation to ProQuest®.

After the defense, if the committee has required major revisions to be approved by one or more of its members, it is your responsibility to provide them with the corrected final version for their approval. They will be asked to submit written confirmation of that approval to the University Graduate Studies Office. Failure to do so could delay conferral of your degree.

After the Defense

Student Status

You can submit the final corrected copies of your dissertation as soon as you address any remaining comments that were brought up during the defense or noted in the registration copy of your dissertation, which will be returned to you usually within a few days before or after the defense. You can take up to one semester following the defense to address any comments, during which you can remain a full-time student. Your degree conferral date will depend on when you submit the final corrected copies of your dissertation.

Final Corrected Copies of the Dissertation

The day after your defense, you will receive an email from the University dean of graduate studies that provides instructions on how to:

- Submit the final corrected copies of your dissertation through ProQuest
- Provide authorization for the release of your dissertation through UR Research
- Complete a mandatory online exit survey
- Verify to the University dean of graduate studies' office that the dissertation has been submitted

Publishing Your Final Dissertation: The University of Rochester requires all doctoral candidates to deposit their dissertations for publication with ProQuest Dissertation Publishing and with the University libraries. Hard copies are not required. The library receives an electronic copy of the dissertation from ProQuest, but students must give the University permission to obtain it.

Registration

Students are required to be registered each semester until the degree has been awarded. If students are not registered by the drop/add deadline, they will be withdrawn.

Important Registration Dates

Refer to the AS&E GEPA calendar or the refund schedule for specific registration and refund deadlines. Deadlines will also be emailed by the Graduate Registrar and included in the AS&E Graduate Student Weekly News newsletter.

Selecting Courses
Course offerings may change prior to the beginning of classes. Go to class schedules for the most up-to-date information. Be sure to check courses for specific prerequisites required. Instructors who include this restriction believe that it is essential for you to have completed the prerequisite course(s).

Registering for Courses in UR Student
All matriculated graduate students must register online. Full-time graduate students taking less than 12 credit hours must have proof of TA or RA responsibilities for the given semester to remain in full-time status. Contact your department administrator as well as your advisor to be sure you are registering for the correct courses before starting online registration.

Continuation of Registration
Matriculated graduate students must maintain continuous registration (fall and spring) until they are awarded degrees, withdraw from the degree program, or are dropped from the degree program by the University. Students maintain continuous registration by registering for credit courses or one of the following courses: 985, 895, 995, 899, or 999 (see definitions below).

Study in Absentia
In certain circumstances, it may be desirable for a full-time matriculated graduate student to engage in study or research for a limited period at another university, research organization, or scholarly institution and to register for appropriate graduate credit at the University of Rochester. All such requests must be made in writing and approved in advance by the GEPA office. Full-time employment is prohibited in this status. See our study in absentia policy for more information.

985 – Leave of Absence
Matriculated graduate students who have not completed course and credit requirements for their degree, and who have been granted a leave of absence upon the recommendation of their departments, and with the approval of the AS&E dean of graduate education and postdoctoral affairs should register for 985.

This course has zero credit hours and no mandatory health fee. There is a flat-rate fee for registration, which must be received by the registration deadline for each semester of leave of absence. Please note that this course will not defer student loans, as it is a less than part-time registration. Students in this category in the spring semester cannot defend dissertations in the summer. See our leave of absence policy for more information.

895 – Continuation of Master's Enrollment
"Plan A" master's degree students who have received written permission from the dean of graduate studies n Arts, Sciences and Engineering to complete the master's dissertation while not in residence and not working full-time on the dissertation should register for 895. "Plan B" master's degree students who have completed all of the required courses, but not all of the requirements for a degree, and are not working full-time on completing the degree requirements, must register for 895.

This course has zero credit hours and no mandatory health fee. There is a flat-rate fee for registration. Please note that this course will not defer student loans, as it is a less than part-time registration. An updated ID card cannot be obtained with this course registration.

899 – Master's Dissertation
"Plan A" master's degree candidates who have completed all requirements for the degree (except the

dissertation) and who are working full-time on the dissertation should register for 899. The student's advisor's name is required. "Plan B" master's degree students who have completed all of the required courses, but not all of the requirements for a degree, and are not working full-time on completing the degree requirements, must register for 895.

This course has zero credit hours but is considered full-time registration. There is a flat-rate fee for registration. The mandatory health fee must be paid, and student loans may be deferred when registering for this course.

995 – Continuation of Doctoral Enrollment
PhD students who have received written permission from the dean of graduate studies n Arts, Sciences and Engineering to complete the doctoral dissertation while not in residence and not working full-time on the dissertation should register for 995.

This course has zero credit hours and no mandatory health fee. There is a flat-rate fee for registration. Please note that this course will not defer student loans, as it is a less than part-time registration. An updated ID card cannot be obtained through this course registration.

999 – Doctoral Dissertation
PhD students who have completed all the requirements for the degree (except the dissertation) and are in residence as full-time students should register for 999. The student's advisor's name is required.

PhD students who have completed all the requirements for the degree (except the dissertation), who are working full-time on the dissertation, and have the permission of the department and the dean of graduate studies in Arts, Sciences and Engineering to be in residence elsewhere, should register for 999A or 999B. (See Study in Absentia)

PhD students should register every semester and pay the required registration fee. When the final two corrected copies of the dissertation are turned in, students are eligible for a refund of the current semester fee for continuing enrollment, according to the same schedule used for the health fee: 75 percent during the first calendar month, 50 percent during the second calendar month, 25 percent during the third calendar month of the semester.

This course has zero credit hours but is considered full-time registration. There is a flat-rate fee for registration. The mandatory health fee must be paid, and student loans may be deferred when registering for this course.

Change of Time Status
Change of time status requires approval from the dean of graduate education and postdoctoral affairs.

Holds
University policy requires that students be current in payment of all tuition and fees prior to the beginning of each academic term. Students who have a delinquent balance at the time of registration will not be permitted to register for the upcoming term. If you have a past due balance, you need to settle your account with the Bursar's Office. You will need clearance to register for the upcoming term's courses.

If your account remains on financial hold at the beginning of the next term, the Bursar's Office may ask the AS&E dean of graduate education and postdoctoral affairs to withdraw you for financial reasons. A financial

hold also prevents the release of your transcript and diploma. Student Access will enable you to check your account for financial holds.

Audit Courses
Both full- and part-time students are allowed to audit courses in related degree programs. * Audited courses appear on students' transcript if the student attends throughout the course. Students who wish to receive credit for such a course can do so by:

- Changing the registration in the Graduate Studies Office prior to the end of the third full week of classes in each semester.
- Paying the required tuition for the course.

*Fee applies. Arts, Sciences and Engineering may decide to pay the fee for PhD student with the approval of the student's faculty advisor and the AS&E dean of graduate education and postdoctoral affairs. See our auditing courses policy for more information.

Drop/Add Courses
A regular semester course can be added or dropped online before the registration deadline and via a registration form for one additional week after the online registration deadline, provided the student obtains the approval of his or her faculty advisor and notifies GEPA on the proper drop/add form. Drop/add forms are available through the department graduate coordinator.

Course drops are not recorded on official transcripts or advising records if they happen before the third week of classes. If you want to drop or add a course after the third week of classes, the drop/add notification sent to GEPA must bear the signatures of the faculty advisor/graduate coordinator and the course instructor.

Dropping credit hours after the third week of a semester or retroactive after the conclusion of the semester is not permitted if the change affects the student's time status (e.g., full-time status changes to part-time) for that semester. Such late drops will be recorded on the official transcript and identified by the grade W. Your course instructor also has the option of assigning an E grade instead.

In exceptional circumstances, the dean of graduate education and postdoctoral affairs may approve dropping a course without record after the start of the third week of classes. Review of the circumstances is initiated by an appropriate written petition.

Courses dropped before the registration deadline will receive 100 percent refund of the tuition. Courses dropped between the registration deadline and the add/drop deadline will receive 50 percent refund of the tuition. Courses dropped after the third week of classes will not receive any refund.

This policy defines the institutional tuition refund when a student voluntarily withdraws (drops) from any course(s) during a period of enrollment while remaining enrolled. The above tuition refund schedule is to be applied to the individual course. This policy does not apply to students who voluntarily or involuntarily withdraw, take a leave of absence, or go on inactive status. For more information about these types of actions, please go to the registrar policy page.

Be sure the following information is completed before handing in a drop/add form:

- Date and term

- Personal: name, University ID number, phone number
- Academic: school, class year, major/degree
- Action: add, drop, or withdrawal
- Course: CRN, subject area, number, credit hours, audit, title
- Signatures and/or approvals

Internships

Research Internship Policy

A graduate practical research internship is designed to allow a student to obtain practical experience in their graduate research field by working on an internship outside the university for a short period of time during their graduate education.

A full-time faculty member supervises the academic portion of the internship. The academic work that needs to be completed is determined by mutual agreement between the student and faculty sponsor. The student must obtain the signature of the faculty member (on the Internship Approval Form) in order to register for an internship. Students are required to submit a short write-up of their internship experience to their internship faculty advisor. The faculty member will provide a grade for the 1 credit internship based on this write-up at the end of the semester. All grades must be added to a student record before a PhD defense may be delivered.

- Internships are registered as 1-credit hour of research and can be taken during the fall, spring, and summer terms.
- The student must register for 1 credit under
    - Full-time internship: 494 (Master's) or 594 (Ph.D.)
    - Part-time internship (less than 20 hours/week, in the Rochester area): 494 (Master's) or 594 (Ph.D.)
- If a full-time internship is taken over the semester rather than over the summer, the student must also register for continuing enrollment, 899A (Master's) or 999A (Ph.D.).
- Each 1 credit internship, up to a maximum of 2, counts toward the total required credits for the degree (30 or 32 for Master's, 90 for Ph.D.) and must be included in the student's Program of Study. To count additional credits of internship beyond 2 toward the degree requirements requires approval of the Dean of Graduate Studies.
- At the PhD level, tuition for internships is paid for by the dean's tuition scholarship when taken within the 90 credits required to earn a PhD and when the internship research credit is included on the Program of Study. If a PhD student would like to take an internship after accumulating 90 credits, the expense of the tuition credit is the financial responsibility of the student or their academic department.
- At the Master's level, tuition expenses for internship courses are the financial responsibility of the student after any Dean's awarded scholarship is applied.
- Health insurance: students currently enrolled in the University of Rochester Student Health Insurance plan will remain on this plan during the internship period.
- Master's students
    - Note that internships represent "research" credit. Thus, in order to complete Plan B for the Master's degree, students must make sure the sum of their

Paperwork

All internships require the following paperwork

- Internship Approval Form (with faculty advisor signature)
- Paper registration form
    - Full-time internship during the summer: register for 494 (Master's) or 594 (Ph.D.)
    - Full-time internship during the semester: register for 494 & 899A (Master's) or 594 & 999A (Ph.D.) In Absentia Request Form
    - Part-time internship during the semester: register for 494P (Master's) or 594P (Ph.D.) as well as additional course or research credits.
- If internship funded by Dean's or Department's FAO, a 506-form charging the student's standard tuition must be submitted via HRMS.
- International students must complete and submit to ISO the ISO CPT form with a copy of the internship offer
- Only two internship credits are permitted withing the MS or PhD Program of Study

Transitional Internship Policy

A graduate transitional internship is designed to allow international students to obtain practical experience in their graduate research field while transitioning to OPT by working on an internship outside the university for a short period of time.

Note: These registrations require a unique Course Registration Number (CRN) to be created. All paperwork is required in the GSO at least 2 weeks prior to the start of the internship to allow time for administrative processing. Approval and registration during the fall and spring terms must be processed before the last day of the semester. Registration requests received less than 2 weeks before the desired internship start date will delay the internship start date.

A full-time faculty member supervises this internship. The work that needs to be completed is determined by mutual agreement between the student and faculty sponsor. The faculty advisor and graduate coordinator must approve and sign the Internship Approval Form to register for the internship. The faculty member must provide a grade for the .5 (half) credit internship at the end of the semester.

- Internships are registered as a .5 credit hour of research and can be taken during the fall, spring, and summer terms.
- The student must register for the .5 credit - 494I (Master's) or 594I (Ph.D.) To register, the student must request their Graduate Coordinator create a hard copy registration form which is available on the ASE Intranet.
- If a full-time internship is taken in the fall or spring semester (not summer), the student must also register for continuing enrollment, 899A (Master's) or 999A (PhD) via an on-line registration.
- It is expected that a single .5 internship will allow sufficient time for a successful defense and OPT approval process. A maximum of 2 (two) .5 credit internships are allowed with Advisor and Dean Approval.
- At the Master's level, tuition expenses for internship courses are the financial responsibility of the student after any Dean's awarded scholarship is applied.
- Health insurance: students currently enrolled in the University of Rochester Student Health Insurance plan will remain on this plan during the internship period if they maintain a full-time registration status.

Transfer Credit Policy

The associate dean of graduate studies may approve, for students who do not present the master's degree, up to 30 credit hours of acceptable graduate work taken at this or another university toward the requirements for the doctoral degree.

Work taken prior to matriculation in a graduate degree program is classified as possible transfer work. Limits on transfer credits are set at the program level. Credit hours may be accepted toward degree requirements if the subjects taken form an integral part of the proposed program of study and if taken within five years of the date of matriculation with a grade of B or higher as interpreted in this University.

Requests for transfer credit must have the approval of the associate dean of graduate studies. Similarly, permission to take work at another institution for transfer credit after matriculation in a graduate program must be approved in advance by the associate dean of graduate studies. Credit hours already applied to two degrees, whether at the University of Rochester or elsewhere, cannot be applied to a third degree at the University. For additional information, please review the graduate studies bulletin.

University of Rochester Undergraduates (Transfer Credits Info)

Arts, Sciences and Engineering allows no more than 10 credits taken prior to matriculation in a graduate program to be transferred in for the master's degree program of study free of charge. If a student wishes to transfer in more than 10 credits for courses taken at the University of Rochester prior to matriculation in a graduate program, the student must pay for these credits. The cost shall be based on the per-credit tuition rate at the time the credit transfer is requested, and any graduate tuition scholarship that has been provided to the student shall be applied to this total tuition cost.

All transfer credits must not have been used as part of the undergraduate degree program and require approval of the program (either the Director of Graduate Studies or the Chair) and the Arts, Sciences and Engineering Dean of Graduate Studies to be applied to a graduate program of study.

Note that programs have their own requirements beyond completion of credit hours, such as distribution requirements, TA requirements, and specific work towards the exit exam or essay that the student must complete to earn a master's degree. Students are encouraged to meet early in their planning process with the program Graduate Administrator and/or Director of Graduate Studies to devise a program of study that will meet all the requirements for the degree.

Illustrative examples:

- Student takes two courses with graduate content during his/her senior year, for eight credits. None of these courses were used to fulfill a requirement for the bachelor's degree. With approval, the student may transfer in all eight credits for the master's program of study without charge.
- Student takes four courses with graduate content during his/her senior year, for 16 credits. None of these courses were used to fulfill a requirement for the bachelor's degree. With approval, the student may transfer in 10 credits from these 16 credits for the master's program of study without charge. If the student wishes to transfer in the remaining 6 credits, he/she will be charged for 6 credits at the current tuition amount, less any tuition scholarship provided to the student in the offer of admissions to the master's program.
- Student takes eight courses with graduate content during his/her senior year, for 32 credits. None of these courses were used to fulfill a requirement for the bachelor's degree. With approval, the student may transfer in 10 credits from these 32 credits for the master's program of study without charge. If the student wishes to transfer in the remaining 22 credits, he/she will be charged for 22 credits at the current tuition amount, less any tuition scholarship provided to the student in the offer of admissions to the master's program. The student will need to matriculate in the master's program after completing the bachelor's degree and complete any program requirements, such as the exit exam, to obtain the master's degree.

Academic Honesty Policy

Academic honesty is a fundamental value that must be shared and upheld by all members of the University of Rochester community. Graduate students in Arts, Sciences and Engineering (AS&E) have the responsibility to understand and abide by the University and AS&E policies, and suspected infractions of these policies will be treated with the utmost seriousness.

A student remains responsible for the academic honesty of work submitted to the University as part of the requirements for the completion of a degree (or any other coursework taken at the University) even after the work is accepted, the degree is granted, or the student is no longer matriculated at the University of Rochester. Ignorance of these standards is not considered a valid excuse or defense.

Academic honesty resources:

- Academic Honesty Policy for Arts, Sciences and Engineering
- Graduate Student Academic Honesty Resources
- Process of Review of Academic Misconduct Flowchart (PDF)

Academic Probation Policy

- All graduate students are expected to maintain high standards of academic performance in their course work and their research. Minimum grades for courses or research work carrying graduate credit are C or S. However, a student can get credit for only one C during their graduate studies.
- Getting Placed on Academic Probation
- A student who receives the grade of C in one or more courses or the grade of E in one or more courses will be considered to have an unsatisfactory record and will be automatically placed on academic probation*. A student on academic probation cannot be awarded a graduate degree. Students in extenuating circumstances may appeal to the dean of graduate studies.
- * Students who receive their first and only C in their final semester are not subject to academic probation.
- Removal from Academic Probation
- A student will be removed from academic probation if the student completes 12 semester hours of graduate credit with no grade lower than B-. If the student receives a grade below B-, the student is subject to removal from the program. In such a case, the student must petition the dean of graduate studies to remain in the program. This petition must be approved by the program director or department chair, and it must include a discussion of the reason for the poor performance and a plan for improved academic performance.

Probation calls for several immediate actions:

(1) The student is to schedule a private interview with the advisor to discuss the circumstances of the poor grade and to consider remedial action. The Graduate Committee expects the student to contact the advisor to schedule this meeting within two weeks from the date of this letter.

(2) After the meeting, the student is to compose a letter with the following elements: (i) an honest explanation of the circumstances that led to the grade of C, (ii) a description of any remedial work that has been agreed upon with the advisor, and (iii) the student's own assessment of his or her ultimate prospects for success in the graduate program. The advisor is asked to co-sign this letter. This letter should be submitted **in hard copy** to the Graduate Committee within one week of the advisor meeting.

Forms & Policies

Please visit the Graduate Education and Postdoctoral Affairs (GEPA) Website for up-to-date information

Forms & Policies : Academics : Graduate Education and Postdoctoral Affairs : University of Rochester

Resources

Academic Planning:

- Course Schedule/Descriptions
- Graduate Bulletin
- Graduate Academic Calendar
- Registration
- Graduate Bulletin
- Graduate Student Association
- Doctoral Theses
- Graduate Student Guidelines on Research Integrity and Conflict of Interest
- Tax Presentation from February 2018 Tax Workshop