Rochester Institute of Technology

Microsystems Engineering Ph.D. Program

Graduate Student Manual

The purpose of the Ph.D. Graduate Student Manual is to acquaint students with the requirements of the Microsystems Engineering program and to help guide them through their course of study. The Manual has been created to capture and clarify the policies and procedures governing graduate study and research in the Microsystems Engineering Ph.D. program. If questions arise, the student can seek clarification from his/her advisor, the Microsystems Engineering Program Office, or the program director.

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INTRODUCTION

The Kate Gleason College of Engineering offers a graduate program leading to the Doctor of Philosophy (PhD) degree in Microsystems Engineering. The program builds on the knowledge and skills of traditional engineering and science with concentration in micro- and nano-scale engineering and systems. Graduate students in the program conduct research in a wide variety of areas including nanotechnology, microelectronics, MEMS and NEMS, nanolithography, photonics, microfluidics, nanoelectonics for biomedical systems, micropower devices, and nanomaterials. The Microsystems Engineering faculty is committed to offering students an education that prepares them to be the innovators and leaders in these technology frontiers.

The Graduate Student Manual is intended to provide the student with information about the program and to help guide them through their program of study. Dedicated faculty and staff are also available to provide additional assistance.

CONTACT INFORMATION

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THE PH.D. DEGREE

The Doctor of Philosophy degree in Microsystems Engineering requires concentration and specialization in an associated research area as well as mastery over the fundamentals of Microsystems Engineering. The degree is awarded in recognition of demonstrated proficiency and high achievement in the student's concentration within the program. A significant contribution to the knowledge in the area of Microsystems Engineering is made through successful dissertation research and publication. The program curriculum has been designed to meet the individual needs of graduate students while ensuring that all students complete a well-rounded program of study.

MICROSYSTEMS ENGINEERING PHD PROGRAM CHECKLIST

The following list summarizes key milestones toward a Microsystems Engineering PhD at RIT.

- ☐ Admission to the program
- ☐ Confirm Fall course registration with the Microsystems Engineering Program Assistant
- ☐ Review initial draft of Program of Study form with Advisor prior to start of Spring semester (completed form due upon completion of Qualifying Exam)
- ☐ Successfully complete the MCSE-702 Introduction to Nanotechnology and Microsystems
- ☐ Register to take the Qualifying Examination. The normal sequence for entering students is to take this exam in the summer at the end of their first year. In consultation with their advisor, and the Program Director, the student may alternatively take the exam during their first Fall-Spring intersession or delay it until their second intersession.
- ☐ Pass the Qualifying Examination
- ☐ Submit a Program of Study form
- ☐ Submit transfer credit form for courses from Master's Degree (if applicable)Research and define dissertation research topic
- ☐ Submit an Advisory Committee form
- ☐ Meet with RIT Wallace College of Engineering librarian
- ☐ Write the dissertation proposal during the second year
- ☐ Register to take the Candidacy Examination (and prepare the proposal defense)
- ☐ Pass the Candidacy Examination no later than the end of the third year and at least one year before the Dissertation Defense
- ☐ Finish all required coursework and continue with research / publications
- ☐ Check with Microsystems Engineering program office to see when you should register for graduation in the student information systems (SIS)
- ☐ Hold periodic reviews of your progress with your advisory committee
- ☐ Hold a Research Review Milestone Meeting (at least six months before the Dissertation Defense)
- ☐ Meet with the Program Assistant to ensure that all certification requirements will be met
- ☐ Publish at least two papers during the course of research (at least one of which must be a refereed journal paper)
- ☐ Complete the dissertation manuscript with input and feedback from advisor and committee
- ☐ Submit thesis title to the RIT Registrar

- Register for the Dissertation Defense with advance notices as described in the Ph.D. Graduate Manual
- Successfully pass the dissertation defense
- Meet with Program Assistant to ensure completion of all certification requirements

MICROSYSTEMS ENGINEERING PHD DEGREE REQUIREMENTS

In order to be granted the PhD degree, the student must satisfy the following minimum requirements:

1. A total of 66 semester credit hours
    a. A minimum of 39 of graduate-level coursework credit hours
    b. A minimum of 18 semester research credit hours
2. Pass the Qualifying Examination. In consultation with their advisor and the Program Director, the student may take the exam during the summer of their first year (preferred), their first Fall-Spring intersession, or their second intersession.
3. Pass the Candidacy Examination (before the end of third year and no less than 12 months before the Dissertation Defense Examination)
4. Hold a Research Review Milestone meeting (at least 6 months before the Dissertation Defense Examination)
5. Publish two papers (including at least one referred journal paper) based on dissertation research
6. Pass the Dissertation Defense Examination

CURRICULUM

A total of 66 credit hours of combined graduate course work and research are required for completion of the program. The course work requires a combination of foundation courses, major and minor technical area courses, and electives. The student must pass the Qualifying Exam, the Candidacy Exam, and the Dissertation Defense Exam for completion of degree requirements.

Phase 1: The first phase of the Ph.D. program is to prepare the student with the foundation in science and engineering required for the program as well as to determine the student's ability to do independent research. This includes the foundation and specialization courses taken during the first year together with the successful completion of the Qualifying Exam. The Qualifying Exam tests the student's ability to think and learn independently, to critically evaluate current research work in microsystems engineering, and to use good judgment and creativity to determine appropriate directions for future research work.

Phase 2: The second phase of the Ph.D. program consists of course work in the Program of Study and preliminary dissertation research. Much of this course work will support the student's research to be conducted in the Third Phase. This second phase will be completed when the student has finished most of the formal course work as prescribed in the Program of Study, has prepared the

Dissertation Proposal and has passed the Candidacy Examination. A student may also publish one or more papers in this phase.

Phase 3: The third stage of the Ph.D. program consists of the completion of the experimental and/or theoretical work needed to complete the student's dissertation along with the additional required publication of results. The Research Review Milestone is held as a meeting in the Third Phase as is the Defense of the Dissertation, which consists of a public oral presentation and examination.

Coursework

The coursework requirements for the Ph.D. degree are divided in four groups to ensure that students complete a well-rounded program of study with the necessary concentration in their specialized field.

Group I: Foundation Courses (4x3=12 hrs + 6 hrs of MCSE-795 Microsystems Ph.D. Seminar)

Four foundation courses and the Ph.D. Seminar are mandatory:

1. MCSE-702 Introduction to Nanotechnology and Microsystems

2. Mathematics (select one)

MTSE-704	Theoretical Methods in Material Science and Engineering
ENGR-707	Engineering Analysis
ENGR-709	Advanced Engineering Mathematics
MATH-601	Methods of Applied Mathematics
MATH-611	Numerical Analysis
MATH-712	Numerical Methods for Partial Differential Equations
MATH-741	Partial Differential Equations I
MATH-742	Partial Differential Equations II

3. Microfabrication (select one)

MCEE-701	Microelectronic Fabrication I
MCEE-602	VLSI Process Modeling
MCEE-605	Lithography Materials and Processes
MCEE-704	Physical Modeling of Semiconductor Devices
MCEE-770	Microelectromechanical Systems
MCEE-732	Evaluation of Microelectronic Manufacturing

4. Materials Science (select one)

MCSE-703	Materials Science for Microsystems Engineering
MTSE-601	Intro to Materials Science
MTSE-617	Materials Degradation
MTSE-702	Polymer Science
MTSE-703	Solid State Science
MTSE-705	Experimental Techniques
MTSE-780	Theory of Microsensors and Actuators
MCSE-xxx	Thin Film Science
IMGS-724	Introduction to Electron Microscopy

5. MCSE-795 Microsystems Ph.D. Seminar (1hr x 6)

Group II: Major Technical Interest Area (4x3=12 hrs) – See Table below

A sequence of four courses in the major technical research area

Group III: One Minor Technical Interest Areas (2x3=6 hrs) – See Table below

A sequence of two courses in a minor technical area.

Group IV: Elective (1x3=3 hrs minimum) – See Graduate Bulletin

These courses can be prerequisite, remedial, or support courses that are approved by the advisory committee of the student and satisfy the course requirements outlined below. Electives can be selected from any graduate program at RIT with the approval of the student's advisor.

Microsystems Engineering Ph.D. Seminar (1x6=6 hrs for yrs 1&2, no credit beyond yr 2)

PhD students are required to take part and attend the seminar for the full duration of their PhD study (beyond their first two years of registering for course credit).

Dissertation Research (18 hrs minimum)

Minimum total hours required: 66 hrs

Note: the total of minimum course credits (39) and the total minimum research credits (18) add to 57 credits. Students should consult with their advisor to address their specific needs and to tailor their program of study to meet the minimum total credits (66) by adding coursework, research or a combination of these.

Group II, III, and IV courses can generally be selected from graduate programs in engineering and science. Some courses also require prior approval of the course instructor. A *partial listing* of graduate courses in the Kate Gleason College of Engineering follows below. Graduate courses offered though other colleges, including the College of Science, can also be appropriate for use in the student's program of study. *Consultation with the student's advisor, the Program Director, and the course instructor is recommended to determine the suitability of these courses for a student's particular program of study. A complete listing of graduate courses can be found in the Graduate Catalog / Bulletin at http://www.rit.edu/upub/pdfs/Graduate_Bulletin.pdf.*

Graduate Courses Organized by Topical Area

Course	Solid-State Devices	Optics & Photonics	NEMS & MEMS	Bio Micro systems	Circuits & Systems
Microsystems Engineering					
MCSE-610 Applied Biofluidic Mechanics and Microcirculation				X	
MCSE-703 Material Science for Microsystems Engineering	X				
MCSE-712 Nonlinear Optics		X			
MCSE-713 Lasers		X			

Course	Solid-State Devices	Optics & Photonics	NEMS & MEMS	Bio Micro systems	Circuits & Systems
MCSE-714 Quantum Mechanics for Engineers	X	X			
MCSE-731 Integrated Optical Devices and Systems		X			
MCSE-771 Optoelectronics		X			
MCSE-xxx Quantum Optics		X			
Microelectronic Engineering					
MCEE-602 VLSI Process Modeling	X				X
MCEE-603 Thin Films	X		X		
MCEE-605 Lithography Materials and Processes	X		X	X	
MCEE-615 Nanolithography Systems		X	X		
MCEE-701 Microelectronic Fabrication I	X	X	X		
MCEE-704 Physical Modeling of Semiconductor Devices	X				X
MCEE-706 SiGe and SOI Devices and Technologies	X				
MCEE-713 Quantum and Solid-State Physics for Nanostructures	X				
MCEE-714 Micro/Nano Characterization	X		X	X	
MCEE-717 Memory Systems	X				X
MCEE-720 Photovoltaic Science and Engineering	X	X			
MCEE-730 Metrology for Failure Analysis and Yield of ICs	X				
MCEE-732 Evaluation of Microelectronic Manufacturing					
MCEE-770 Microelectromechanical Systems			X		
Electrical Engineering					
EEEE-602 Random Signals and Noise					
EEEE-603 Matrix Methods in Electrical Engineering					
EEEE-605 Modern Optics for Engineers		X			
EEEE-610 Analog Electronics	X				X
EEEE-617 Microwave Circuit Design	X	X			
EEEE-620 Design of Digital Systems					X
EEEE-621 Design of Computer Systems					
EEEE-629 Antenna Theory					
EEEE-636 Biorobotics/Cybernetics					
EEEE-647 Artificial Intelligence Explorations					
EEEE 661 Modern Control Theory					
EEEE 669 Fuzzy Logic and Applications					
EEEE-670 Pattern Recognition					
EEEE-678 Digital Signal Processing					
EEEE-685 Principles of Robotics					
EEEE-689 Fundamentals of MEMS			X		
EEEE-692 Communication Networks					
EEEE-693 Digital Data Communication					
EEEE-710 Advanced Electromagnetic Theory	X	X			
EEEE-711 Advanced Carrier Injection Devices	X				
EEEE-712 Advanced Field Effect Devices	X				
EEEE-713 Solid-State Physics	X	X			
EEEE-718 Design and Characterization of Microwave Systems					

Course	Solid-State Devices	Optics & Photonics	NEMS & MEMS	Bio Micro systems	Circuits & Systems
EEEE-720 Advanced Topics in Digital Systems Design					
EEEE-721 Advanced Topics in Computer Systems Design					
EEEE-726 Mixed-Signal IC Design					X
EEEE-730 Advanced Analog IC Design					X
EEEE-733 Robust Control					
EEEE-765 Optimal Control					
EEEE-766 Multivariable Modeling					
EEEE-768 Adaptive Signal Processing					
EEEE-779 Digital Image Processing					
EEEE-780 Digital Video Processing					
EEEE-781 Image and Video Compression					
EEEE-784 Advanced Robotics					
EEEE-787 MEMS Evaluation			X		
EEEE-794 Information Theory					
EEEE-797 Wireless Communication					
Mechanical Engineering					
MECE-601 Math I for Engineers					
MECE-602 Math II for Engineers					
MECE-605 Finite Elements					
MECE-606 Systems Modeling					
MECE-620 Introduction to Optimal Design					
MECE-623 Powertrain Systems and Design					
MECE-624 Vehicle Dynamics					
MECE-629 Renewable Energy Systems					
MECE-638 Design of Machine Systems					
MECE-643 Continuous Control Systems					
MECE-644 Introduction to Composite Materials					
MECE-656 Applied Biotransport				X	X
MECE-657 Applied Biomaterials				X	X
MECE-658 Introduction to Engineering Vibrations					
MECE-710 Fuel Cell Technology					
MECE-730 Design Project Leadership					
MECE-731 Computational Fluid Dynamics				X	X
MECE-733 Sustainable Energy Management					
MECE-738 Ideal Flows					
MECE-739 Alternative Fuels and Energy Efficiency					
MECE-743 Digital Control Systems					
MECE-744 Nonlinear Control Systems					
MECE-746 Engineering Properties of Materials	X				
MECE-751 Convective Phenomena					
MECE-752 Tribology Fundamentals					
MECE-754 Fundamentals of Fatigue and Fracture					
MECE-758 Intermediate Engineering Vibrations					
MECE-785 Mechanics of Solids			X		
Courses offered in the College of Science					
IMGS-633 Optics for Imaging		X			
MTSE-601 Materials Science					
MTSE-617 Material Degradation					

Course	Solid-State Devices	Optics & Photonics	NEMS & MEMS	Bio Micro systems	Circuits & Systems
MTSE-702 Polymer Science					
MTSE-703 Solid State Science	X				
MTSE-704 Theoretical Methods in Materials Science and Engineering					
MTSE-705 Experimental Techniques	X	X			
MTSE-780 Theory of Microsensors and Actuators			X		
CHMA-621 Advanced Instrumental Analysis Lab					
CHMA-711 Advanced Instrumental Analysis Biochemistry				X	
CHMB-610 Adv Protein Biochem: Structure and Function				X	
CHMB-702 Protein Conformation and Dynamics				X	
CHMB-704 Biochemistry of Nucleic Acids				X	
CHMI-764 Modern Inorganic Chemistry					
CHMO-636 Spectrometric Identification of Organic Compounds					
CHMO-637 Advanced Organic Chemistry					
CHMO-710 Literature Exploration of Organic Synthesis					
CHMO-739 Advanced Physical Organic Chemistry				X	
CHMP-753 Computational Chemistry					
CHPO-706 Polymer Chemistry					
CHPO-707 Polymer Chemistry				X	
CHPO-708 Polymer Synthesis & Characterization Lab					
PHYS-611 Classical Electrodynamics I	X	X			
PHYS-612 Classical Electrodynamics II	X	X			
Industrial and Systems Engineering					
ISEE-601 Systems Modeling and Optimization					
ISEE-626 Contemporary Production Systems					
ISEE-661 Linear Regression Analysis					
ISEE-701 Linear Programming					X
ISEE-702 Integer and Nonlinear Programming					X
ISEE-703 Supply Chain Management					
ISEE-704 Logistics Management					
ISEE-710 Systems Simulation					
ISEE-711 Advanced Simulation					
ISEE-720 Production Control					
ISEE-723 Global Facilities Planning					
ISEE-728 Production Systems Management					
ISEE-730 Biomechanics					
ISEE-731 Advanced Topics in Human Factors and Ergonomics					
ISEE-732 Systems Safety Engineering					
ISEE-740 Design for Manufacture and Assembly					
ISEE-741 Rapid Prototyping and Manufacturing			X	X	
ISEE-745 Manufacturing Systems					
ISEE-750 Systems and Project Management					
ISEE-751 Decision and Risk Benefit Analysis					
ISEE-752 Decision Analysis					
ISEE-760 Design of Experiments					

Course	Solid-State Devices	Optics & Photonics	NEMS & MEMS	Bio Micro systems	Circuits & Systems
ISEE-770 Design Project Leadership					
ISEE-771 Engineering of Systems I					
ISEE-772 Engineering of Systems II					
ISEE-775 Advanced Systems Integration					
ISEE-781 Excellence in New Product Development					
ISEE-782 Product Development in the Extended Enterprise					
ISEE-783 Advanced Topics in New Product Development					
ISEE-785 Fundamentals of Sustainable Engineering					
ISEE-786 Lifecycle Assessment					
ISEE-787 Design for the Environment					
Center for Quality and Applied Statistics					
CQAS-611 Statistical Software					
CQAS-621 Statistical Quality Control					
CQAS-670 Designing Experiments for Process Improvement					
CQAS-672 Survey Design and Analysis					
CQAS-682 Lean Six Sigma Fundamentals					
CQAS-683 Lean Six Sigma Project					
CQAS-701 Foundations of Experimental Design				X	
CQAS-721 Theory of Statistics I					
CQAS-722 Theory of Statistics II					
CQAS-741 Regression Analysis					
CQAS-747 Principles of Statistical Data Mining I					
CQAS-751 Nonparametric Statistics					
CQAS-756 Multivariate Analysis					
CQAS-762 SAS Database Programming					
CQAS-773 Time Series Analysis and Forecasting					
CQAS-784 Categorical Data Analysis					
Computer Engineering					
CMPE-610 Analytical Topics in Computer Engineering					
CMPE-630 Digital Integrated Circuit Design					X
CMPE-655 Multiple Processor Systems					X
CMPE-660 Reconfigurable Computing					X
CMPE-661 Hardware and Software Design for Cryptographic Applications					
CMPE-663 Real-Time and Embedded Systems					
CMPE-665 Performance Engineering of Real-Time and Embedded Systems					
CMPE-670 Data and Communication Networks					
CMPE-680 Digital Image Processing Algorithms					
CMPE-685 Computer Vision					
CMPE-730 Advanced Digital Integrated Circuit Design					X
CMPE-750 Advanced Computer Architecture					X
CMPE-755 High Performance Architectures					X
CMPE-770 Wireless Networks					
CMPE-789 Special Topics in CE (Brain-Inspired					X

Course	Solid-State Devices	Optics & Photonics	NEMS & MEMS	Bio Micro systems	Circuits & Systems
Computing)					
CMPE-731 Design and Test of Multi-Core Chips					X

General Curriculum Requirements

- The student's Program of Study must be approved by the advisor and director.
- The total number of credit hours applied toward the PhD degree will depend upon the highest degree completed by the student before entering the program, as well as the relevancy of coursework towards the student's Program or Study.
- Students entering the PhD program with a Master's (MS) degree may be permitted up to a maximum of 24 hours toward the minimum 39 hours of coursework required for the degree, based on the approval of the Program Director and confirmation by the Registrar (if applicable).
- Students entering the program without any prior graduate work must complete a minimum of 39 credit hours of coursework.
- Students may take graduate courses (600-900 level) that are approved for the Microsystems Engineering PhD program academic plan.
- All PhD students are required to maintain a cumulative grade point average of 3.0/4.0 to remain in good standing in the program.
- A maximum of 6 research credits may be taken any semester. It is suggested that the student and advisor balance the research credits that are taken prior and after the completion of the Candidacy Exam to best represent the student's research efforts.
- After completing the required dissertation credits, a student must remain active by registering for zero to one credit of Continuation of Doctoral Research.
- Full time status for RIT graduate students is 9 to 18 credit hours per semester.
- Part time students, with approval of the director, may take 6 hours of course work instead of the MCSE-795 Microsystems Engineering Seminar credits.
- Students are discouraged from taking more than 18 credit hours per semester and must have the permission of both their advisor and the program director. Student may be charged additional tuition for more than 18 credits at the current credit hour rate.

Program of Study

Based on the requirements of the Microsystems Engineering PhD program, a student should finalize a Program of Study after passing the Qualifying Exam and no later than the beginning of the Spring semester of the second year. The form should be signed by the student, the advisor, and the director. The Program of Study should be reviewed periodically by the student and the advisor and modifications should be made as necessary. Upon completion of the Candidacy exam, the student's advisor and advisory committee may add additional coursework requirements so that the student is sufficiently prepared to carry out and complete his/her dissertation research.

Dissertation Research Credits

A minimum of 18 and a maximum of 27 research credits are required for the PhD degree in Microsystems Engineering. A maximum of 6 research credits may be taken any semester. After completing his/her required dissertation credits, a student must remain active by registering for zero to one credit of Continuation of Research.

Applying Coursework from other Schools toward the PhD

The transfer of credits from graduate programs at other schools is based on the approval of the program director. Requests are made through the Ph.D. program office. Upon approval of credit transfer, the Program of Study plan serves as an agreement between the student and the Microsystems Engineering Program to permit the student to use classes from another school toward the PhD requirements.

- Students entering the PhD program with a Master's degree may be permitted transfer of credit not to exceed 24 credit hours
- Students who have completed graduate degree coursework from another university and wish to transfer credit must request credit transfer for each eligible class. Approval is given by the program director. This should be completed prior to preparing the program of study plan.
- Students should list classes taken at other schools along with RIT classes on their program of study plan.
- Outside classes must be listed as they appear on the other school's transcript, using that school's numbering (if any), course name, and grade awarded.
- The credit hours for classes completed elsewhere should be reported in semester hours.
- Approval of the PhD Program of Study by the program director serves as documentation that the courses will be used toward the PhD coursework requirement.
- PhD students are not permitted to use any pass/fail courses toward course credit hour requirements.

Registration for Courses

Students are responsible for course registration each semester. On-line registration takes place during each preceding semester. Students typically have the opportunity to register by July or early August of the summer prior to their first year. It is the responsibility of students to make appointments with their advisor (or, for incoming students without an advisor, the program director) at the time of early registration to facilitate course substitutions, elective requests and possible transfer credit requests. The Microsystems Program Assistant can help first year students with this process.

Schedule Verification and Changes

Following early registration, students should verify their schedule on-line through the Student Information System. The schedule should include all courses for which the student is registered as of the date of issue. A student may change their schedule at any time up to the end of the first six days of the semester, following the procedure outlined by the RIT Registrar. Students are strongly encouraged to consult with their advisor before adding or dropping classes. Changes in a course schedule through this process are not reflected on a student's semester grade report or permanent record.

Course Withdrawal

If a student wishes to stop participating in a class following the six-day add/drop period, the student must officially withdraw from a course and will receive a grade of W. Students should discuss any

withdrawal with the instructor and their advisor. This W grade will be reflected on a grade report and permanent record. A course withdrawal resulting in a W grade may be obtained through the end of the twelfth week of the semester. After the twelfth week and up to the end of the semester, a "W" can only be assigned with the permission of the instructor, the director and dean. In unusual situations, a "W" may be granted after the last official class day. Such an extraordinary request is administered through the Provost's Office.

Repeating a Course

For graduate students, approval from the dean or dean's designee of the student's home academic unit is required for any graduate courses a student wishes to take a second time. For a student whose program is housed outside the college structure, the approval of the director or director's designee of the student's academic unit is required. If permission to take a course a second time is granted, the grades of all courses attempted will count in calculating the graduate cumulative grade point average.

Schedule of Record

The student should check their course registrations in the on-line student information systems (SIS) carefully. Inaccurate information should be reported to the Ph.D. program office for a correction to be made. It is the student's responsibility to check the accuracy of this information and to pursue the necessary corrections. Official registration for a course that a student does not attend could result in course overload, F grades, and loss of funding. Lack of registration for a course will result in a student receiving no credit for the course.

Responsibility

It is the student's responsibility to understand the requirements of the Microsystems Engineering Ph.D. degree program. Progress toward achievement of a degree is maintained by the Microsystems Engineering Ph.D. program office. Access to that information is available to each student upon request. All degree requirements are published yearly in the RIT Graduate Bulletin. Questions regarding changes made in the curriculum during a student's program of study should be directed to the program office.

Time Limitations: the "Seven-Year Rule"

All candidates for the doctoral degree must maintain continuous enrollment during all phases of the program, including the research phase once coursework is complete. Such enrollment is not limited by the maximum number of research credits that apply to the degree. Normally, full-time students complete the course of study for the Ph.D. in an average of four to six years, depending on the degree level upon entering the program, among other things. The seven-year rule requires that all courses used towards the Microsystems Engineering Ph.D. program be completed within seven (7) years of the date the student passes the Qualifying Exam. The purpose of the rule is to ensure that graduate students have current knowledge in their fields of study when certified by RIT. Prerequisites courses are excluded from this rule.

If a student does not complete all program requirements within the seven-year time period, course(s) more than seven years old can no longer be counted towards the requirements of the program of study. If this occurs, the student must complete additional course(s) to replace the credit that has expired. If extenuating circumstances prevent a student from completing within the 7-year timeframe, an appeal must be made to the Dean of Graduate Studies for permission to complete the degree while retaining the expired course(s). In some cases, extensions of the seven-year rule may be granted. Petition for an extension is initiated via consultation with the student's advisor and written request to the PhD program director.

Residency

All students in the program must spend at least two consecutive semesters as resident full-time students to be eligible to receive the doctoral degree. A full-time academic workload is defined as a minimum of nine academic credits per semester or an equivalent amount of research, as certified by the program director.

FELLOWSHIPS

Fellowships in the Microsystems Engineering Ph.D. program are divided into two categories, industrial fellowships and outside fellowships.

Industrial Fellowships

The Microsystems Engineering program has strong affiliations with industrial partners, some of which offer fellowship support for students performing research in areas of interest to them while others are open to all qualified students. These fellowships are often tied to faculty members in these research fields. Examples follow, but such fellowships are not limited to these. Students should seek out additional information and opportunities.

IBM Ph.D. Fellowship Program

The IBM Ph.D. Fellowship Awards Program is an intensely competitive worldwide program, which honors exceptional Ph.D. students who have an interest in solving problems that are important to IBM and fundamental to innovation in many academic disciplines and areas of study.
http://www.research.ibm.com/university/phdfellowship/

Semiconductor Research Corporation GRC Fellowship

The Global Research Collaboration (GRC) graduate fellowship program supports students at the doctoral level that are involved in fields related to the semiconductor industry. http://grc.src.org/member/about/aboutgfp.asp

Outside Fellowships

Fellowships are also available to qualified students and are usually based on national competition. The Microsystems Engineering Program encourages students to apply for these and other Fellowships based on guidance from their advisor.

Department of Energy Computational Science Graduate Fellowship (DOE CSGF)

This fellowship is for exceptional undergraduate seniors or first or second year graduate students planning full-time study toward a PhD. in the physical, engineering, computer, mathematical, or life sciences. Applicants must be US citizens or permanent resident aliens.
https://www.krellinst.org/csgf/application.

Ford Foundation Predoctoral Fellowships for Minorities

These fellowships are awarded to underrepresented minority students for graduate study. http://www7.nationalacademies.org/FORDfellowships/fordpredoc.html

Fulbright Scholar

These fellowships were set up to foster closer relations between the United States and other counties. http://www.iie.org/fulbright

Hertz Foundation Fellowships

These fellowships are awarded to outstanding entering graduate students for a five-year-period.

http://www.hertzfoundation.org

Science, Mathematics and Research for Transformationa (SMART) Defense Scholarship
These scholarships are directed to promote the education on students in STEM studies.
http://smart.asee.org

The Naval Research Enterprise Internship Program (NREIP)
The NREIP offers summer research opportunity at a participating Navy research laboratory.
http://nreip.asee.org

National Science Foundation Fellowships
These fellowships are given by the National Science Foundation to promising students beginning their graduate career.
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=6201

NVIDIA Graduate Fellowship
The Fellowship Program supports candidates conducting advanced research in computer graphics, computer science, computer engineering, electrical engineering, high-performance computing, and computational science and engineering. Candidates should have completed at least one year of their doctoral program at the time of application.
http://www.nvidia.com/page/fellowship_programs.html

National Defense Science and Engineering Graduate (NDSEG) Fellowships
As a means of increasing the number of U.S. citizens and nationals trained in science and engineering disciplines of military importance, the Department of Defense (DoD) awards fellowships to individuals who have demonstrated ability and special aptitude for advanced training in science and engineering. https://ndseg.asee.org/

THE QUALIFYING EXAMINATION

Every graduate student pursuing a Microsystems Engineering PhD degree must take the Qualifying Examination. The Qualifying Examination tests the student's ability to think and learn independently, to critically evaluate current research work in the field of Microsystems Engineering, and to use good judgment and creativity to determine appropriate directions for future research work. The exam must be completed successfully before a student can submit a thesis proposal and attempt the PhD Candidacy Examination.

- The PhD Qualifying Exam is offered at the end of each spring semester and during the intersession. The normal time to take the exam is at the end of the students first spring semester. However, with advisors approval, the student may take the exam early (during the first intersession) or later (during the 2nd intersession).
- Students intending to take the exam must submit a registration form to the program director by the deadlines announced by the director.
- Students classified as PhD candidate students at the time of admission must pass the PhD Qualifying Examination within their first year of the program.
- If a student fails to complete the exam once registered, it will be considered a failure.
- Exemptions for these requirements may be granted to part time students only when prior arrangements are made with the program director.
- Students who are unable to take the Qualifying Exam for reasons beyond their control should contact the program director.

Goals of the Qualifying Exam

The goal of the Qualifying Exam is to a) determine the student's ability to conduct independent research and to b) determine that the student has the proper background to pursue his/her research.

The examination is based upon the student's critical evaluation of current research conducted in a field related to Microsystems Engineering. At the start of the exam process, the graduate faculty of the PhD program will give each student three unique substantive research articles that have been published recently (no more than four years) in peer-reviewed journals. The student is given five days (Monday to Friday) to choose one of these articles as the substance of his/her exam. During the next several weeks, the student reviews the chosen article and all relevant material relating to the article, prepares a written evaluation of the article, and gives an oral presentation to defend his/her point of view on the research and publication. The student must demonstrate an ability to understand the technical aspects of the research, the experimental and/or theoretical approaches used in the investigation, and the significance of the research findings. The student must also discuss any additional work that might be appropriate to strengthen the research described in the article and/or expand upon the work to advance the state of knowledge. In particular, the student is asked to:

1. Identify the questions addressed by the author (i.e., What are the author's hypotheses? What was unknown in the field of study prior to the author's work? What are the key issues that the author is investigating, and why are they important to the field?)
2. Formulate a critical appraisal of the author's contribution to the solution of those questions and the significance of the contribution.
3. Uncover and understand the relevant other work and references related to the research.
4. Propose in concrete terms the research that might be done to extend and (if necessary) improve upon the study discussed in the article.

The student's evaluation of the research article is presented in two parts. First, a written report not exceeding 15 single-spaced pages is prepared and submitted to a faculty committee for evaluation. Then, the student makes an oral presentation (approximately 45 minutes) before the faculty committee to elaborate on and defend the positions taken in the written document. After the presentation the examining committee will ask questions on the written report and presentation. Then the committee will ask questions that assess the students understanding of fundamental principles related to their background. The examining committee will consist of three or more faculty members from among the core and extended faculty of the Ph.D. program. At least one of the members must be a core faculty member of the program.

Qualifying Examination Assessment

The results of the Qualifying Exam are discussed by the examining committee immediately following the completion of the exams and an assessment is made and recorded by the examining committee. The examining committee evaluates the Exam and reports results to the core faculty. The evaluation by the committee includes the following criteria:

1. Quality of the written document (20%)
2. Presentation quality (organization, layout, structure of slides) (10%)
3. Presentation delivery/communication ability (10%)
4. Understanding of presented materials (15%)
5. Capability of independent thinking and to propose create alternatives. Ability to critically review and extend work (25%)
6. Students understanding of fundamental principles (20%)

An evaluation of the student's potential for continuation with the Ph.D. degree is made in a special meeting by the core faculty based on the results reported by the examining committee. The faculty reviews the student's grades, classroom performance, research progress, and performance on the Qualifying Examination to decide whether to encourage the student to continue in the PhD program, identify a research topic, and prepare for the PhD proposal and Candidacy Examination. The core faculty evaluates the overall student's performance and makes their decision to grant one of the following:

1. An unconditional pass
2. A conditional pass with recommended remedial action(s)
3. A failure

The decision is communicated to the student by the advisor or another faculty member assigned by the core faculty.

PH.D. ADVISING

PhD supervision and advising is carried out by the student's advisor, advisory committee, and the program director.

The Research Advisor

In the first year of their program, a student is expected to identify a research advisor and report that advisor's name to the PhD program director. Typically, the student selects a research advisor who also then acts as an academic advisor. Advisors are prepared to assist students with issues regarding curriculum requirements, elective choices, stipend support, presentations and publication, RIT support facilities, and concerns of a more personal nature (such as time management). An advisor selection should be reported no later than beginning of the semester following the student's successful completion of the Qualifying Examination. It may be necessary for a student to change advisors during the process of identifying a suitable dissertation topic. In such an event, any change should be promptly reported to the PhD program director.

Ph.D. Advisory Committee

After passing the Qualifying Examination, and during the process of formulating a dissertation research proposal, the student together with his/her advisor should also form an advisory committee. The committee must include a minimum of four people including the advisor. The research committee will help supervise the student's research, including review of the research proposal (typically as part of the PhD Qualifying Exam), meeting with the student during the course of the research, and conducting the dissertation defense.

The specific requirements for the committee are:

- Four or more members (including the advisor) are necessary
- Members should represent at least two concentration areas
- Members should include faculty from at least two departments
- A committee member from industry or a government research lab is beneficial but not required
- The advisor is the chair of the committee for all examinations

Prior to the defense of the dissertation, an additional external committee member will also be assigned by the program director (the "external member"). The external member must be a tenured member of the RIT faculty who holds a PhD and is not a core faculty member of the Ph.D. program.

THE RESEARCH PROPOSAL

A research topic is chosen by the student and his/her research advisor, which will be the basis for the dissertation. The research proposal sets forth both the exact nature of the matter to be investigated and a detailed account of the methods to be employed. In addition, the proposal usually contains material supporting the importance of the topic selected and the appropriateness of the research methods to be employed. The proposal should not be construed as a "binding

contract" between the committee and the student, but as a somewhat flexible agreement that is expected to evolve as the research progresses.

Proposal Goals

The Candidacy Exam (see below) is carried out to assess the student's preparedness to carry out the research as put forth in the research proposal. The proposal (the only written component of the Candidacy Exam) should address the following areas:

Dissertation Subject - What is the proposal subject? What are its limits? This should probably be stated at the beginning of the proposal.
Methodology - What types of questions will the dissertation address, and how will it try to answer it?
Significance - Why is the subject important? What light may it shed on larger questions, or in what other way may it contribute to our field. Is the subject of sufficient interest that the dissertation is likely to be publishable?
State of existing scholarship - To what extent has the subject already been studied? What are the strengths or deficiencies of the existing scholarship?
Work Accomplished - How far has the student already progressed into the study?
Work Remaining - What research will be required, and where will it be done? How long is it likely to take? Are there any special problems that may affect the course of the dissertation work?
References – A thorough list of relevant literature references pertaining to the subject.
Timeline - Tentative schedule and plan for the completion of the dissertation.

Additionally, the proposal should answer these questions:

1. What is the problem?
2. Who cares? (an argument about its importance)
3. What have others done? (the literature review)
4. What is your approach? (your general approach, the new idea)
5. What are you going to do explicitly?
6. What will happen? (or did happen, if you have results)
7. What does this mean? (in terms of answering the problem)
9. Where will you publish these results?

Proposal Guidelines

The proposal is a substantial document and its importance should not be underestimated. A proposal should demonstrate that you have a thorough insight into the nature of a problem as well as the means to explore it. It should explain what needs to be solved and the means by which you can solve it. It should also demonstrate that you understand the context of the problem and that you have thought through the implications of the research. You need to convince the reviewer (in this case your research advisor, your committee, and the reader) that your planned project will lead to a meaningful result and will do so in a reasonable amount of time. Writing the research proposal should not become intimidating as it is important to complete this phase of the program in a timely manner. Although it is often necessary to show some preliminary results in the proposal, the bulk of

the dissertation research is carried out after its acceptance. The general requirements of a good proposal are to:

1. Convince your advisor and committee that you are qualified to carry out the research project.
2. Convince your advisor and committee that the problem is academically and intellectually promising, meaningful and interesting.
3. Convince your advisor and committee that your approach will be carried out successfully and on time. This requires that you give a detailed explanation of your objectives, experimental approach, and timetable.

The following format is suggested for the Research Proposal. Modifications to the format can be made based on the advice and the approval of the research advisor.

1. Cover page

2. Abstract – summarize and use concise statements which should that highlight the importance of your project.

3. Introduction - state the problem, the context, and your proposed approach.

4. Objectives - this is the work statement and it may be convenient to present it in the form of interrelated tasks.

5. Background - This section provides the context in which your work will exist. It should review where the current state of the art is and point out where it is not so that the contribution you propose to make is clear.

6. Approach - This section builds on the previous one to clarify how you propose to make a contribution based on the context you have defined. The materials, methods, models, etc. you propose to use and the results you expect to achieve should be clearly stated. You should build a case in this section to show that you understand the problem, have a well-reasoned approach for addressing the problem, and have a firm basis for expecting your approach to be fruitful. Finally, based on your review in the previous section you should point out the relative importance of your proposed contribution.

7. Preliminary results and discussion – Some exploratory research may be needed to confirm that the research area is relevant or promising, or to determine whether the work can be carried out in the allotted time. Although the preliminary results should not represent a large portion of the proposed project, it is also important that all relevant results to date be included in the proposal.

8. Timetable - Divide the work into major tasks which may be listed in bullet form with descriptive detail. A Gantt chart is a very useful tool.

9. Budget - The previous task breakdown can be used to determine costs. For many proposals, this section can be an estimate of the cost of materials and equipment. Include the cost of any services and machine time as well as items that are available at no cost.

10. Appendices - Anything that does not quite fit into the text because it disrupts the continuity.

11. References – Your proposal should include a complete and thorough list of references that are relevant to your research topic. References should be numbered sequentially. Follow

reference guidelines established by IEEE, AIP, ACS, or others based on guidance from your research advisor and published in styles guides and manuals.

Style guides are very useful for the preparation of proposals, papers, and documents and can be found through many resources including:

AIP Style Manual at:
http://www.aip.org/pubservs/style/4thed/toc.html
IEEE Information for Authors at:
http://www.ieee.org/publications_standards/publications/authors/index.html
ACS Style Guide at:
http://www.lib.berkeley.edu/CHEM/acsstyle.html

Additional help and information can be found from RIT's Wallace Library at:
http://infoguides.rit.edu/content.php?pid=523581&sid=4306747 and
http://infoguides.rit.edu/content.php?pid=166375

Using the Library

Each RIT college has a Reference Librarian to serve as liaison. The Reference Librarian for the Kate Gleason College of Engineering is your first contact for consultation and assistance related to your library and literature research needs. There are more than 200 databases licensed by RIT Libraries to support faculty and student research. You will find scholarly information in all disciplines and many resources designed for graduate level. These databases give you access to information that is not available freely on the Internet. More information can be accessed at:
http://infoguides.rit.edu/microsystems .

CANDIDACY EXAMINATION (THE PROPOSAL EXAM)

The Candidacy Examination is an oral examination based on the dissertation research proposal. The purpose of the exam is to allow the committee to judge the student's ability to execute a research task and to communicate the results. The exam also serves to evaluate the proposed topic to ensure that, if completed as posed, it constitutes an original contribution to knowledge.

Requirements of the Exam

There are several requirements related to this exam. These include:

- The student is expected to make reasonable and consistent progress toward identifying a PhD dissertation topic, which typically involves performing comprehensive research under the guidance of the advisor.
- Once the student and advisor identify a mutually satisfactory dissertation topic, the student should plan to take the Candidacy Examination.
- A student is expected to pass the Candidacy Examination by the end of their third year. Students are strongly encouraged to begin writing their proposal during their second year and complete it by the beginning of the third year.
- Examination must occur at least 12 months before the Dissertation Defense Examination.
- A student has a maximum of two attempts to pass the Candidacy Exam. Students may pass this examination and go on to complete the remaining dissertation research with reservations from the proposal committee. If the committee has reservations, a "conditional pass" may be indicated, noting that one or more of the following is expected of the student:
    - completion of additional courses that the committee feels are important for proper preparation
    - continuing the research until a better definition of a proposed topic is presented
    - improving oral presentation skills
    - improving written communication skills
    - other concerns determined by the committee may also apply.

Unless the arrangements for a conditional pass specifically require that the oral presentation be repeated, it generally does not need to be. The committee may also consider the student's proposal and/or presentation to not be of sufficient quality to pass. If this occurs, the committee specifies to the student exactly what is required of the student.

Candidacy Exam Guidelines

- Students are expected to adhere to all requirements of the Ph.D. Candidacy Exam.
- The student should file a request to take the Candidacy Exam at least two weeks prior to the planned exam.
- The Candidacy Exam is a closed presentation and defense of the Dissertation Proposal.
- The only written component of the exam is the proposal, otherwise it is an oral exam.
- The student in consultation with his/her advisor and the advisory committee schedule the date and time for the exam.
- The student should submit copies of the proposal to the advisor, the advisory committee, and the program director at least two weeks before the date of the exam.
- The student presents his/her proposal in approximately 45 minutes but not exceeding 60 minutes.
- Following or during the presentation the committee can ask questions. There is not a limit on the amount of time allowed for questioning after the presentation but the student should not expect less than 60 minutes.
- Questions can be directly or indirectly related to the proposal subject.
- The advisor will serve as the chair of the Candidacy Examination committee.
- The presentation should focus on the background material pertinent to the proposed dissertation topic and the definition of the dissertation topic
- At the end of the Exam the committee will evaluate the student's performance and inform him/her of the result.
- The committee will report the results of the Candidacy Exam to the program director.

RESEARCH PROGRESS

After passing the Candidacy Exam, students are expected to report and discuss research progress on a regular basis with their advisor as well as their advisory committee. These regular discussions should at a minimum include the research progress, milestones, modifications to direction, and plans for future work.

Time Management

More often than not, students seriously underestimate the amount of time required to complete a thesis or dissertation project. It is important, therefore, that the student and advisor work together to design a reasonable plan to meet milestone requirements, publish results, complete the dissertation research, and prepare the manuscript. The student should be continuously aware that there are many people that depend on the timely completion of the tasks associated with his/her research project. These include the advisor, the committee, the funding organization, the program director, the dean, journal editors and conference committee chairs if the work is being published or presented, as well as family and friends. Time management is not only important for the tasks associated with the student's research project, it will be a necessary part of the student's professional career as well. The process of writing proposals, conducting research, and reporting results will continue to play a large role in a student's career after completion of the PhD.

Different time management strategies work for different people. Below are suggestions that may be helpful when conducting research and writing the dissertation. It is recommended that the student and advisor discuss some of these strategies.

- With the help of your advisor, set deadlines for yourself and stick to them. Alternately, give yourself some leeway in your deadlines so that if the occasion arises, you have got some of extra time built into your schedule.
- Map out your whole schedule in as detailed a manner as possible. Block out time for all your daily obligations, and include plenty of time for research and writing. If possible, make this a regular schedule.
- Be realistic about how much time you will need. This is a large project and high quality is expected so don't underestimate the time you'll need to devote to this. If you know you are a slow writer, keep this in mind as you put together your schedule.

The Research Review Milestone Meeting

The Research Milestone Review Meeting is administered by the student's advisor and advisory committee between the time that the student passes the Candidacy Exam and he/she registers for the Dissertation Defense. This normally occurs approximately six months prior to the dissertation defense. The necessary meeting request form can be found on the program's web site and should be submitted prior to the meeting. The student and advisor should schedule the meeting with the advisory committee and a convenient time and location. The purpose of this meeting is to get the student together with his/her advisor and the entire advisory committee to discuss progress and future plans necessary to meet the final goals of the dissertation. This ensures that all involved agree on what is necessary for the student to complete the research and determine whether any additional work may be necessary. Upon evaluation of the student's progress, the advisor and

committee should report results to the Ph.D. program office, indicating whether the committee is satisfied as well as any recommendations for further action. The student should then meet with the Microsystem Engineering program assistant to ensure that all requirements will be met for degree certification.

THE DISSERTATION

The culmination of a student's hard work toward his/her PhD is the publication of their research. In addition to developing experimental and technical skills during the creation of research, a student needs to acquire the necessary literary skills to communicate results to others. The preparation of the proposal and dissertation is the vehicles through which these skills are demonstrated. It is also expected that these skills are developed through the publication of technical papers and communications. Adherence to a set of guidelines is necessary so that any research can not only be presented to others but so that it can also be critically reviewed. It is important that the student realize that adherence and consistency is important. The faculty of the Microsystems Engineering PhD program has developed a set of guidelines that students should follow as they prepare their dissertation manuscript. It is the prerogative of the student's advisor to further tailor these to suit a particular situation and it is the responsibility of the student to follow these requirements. The format of the dissertation should conform to the requirements for publication set forth by the Institute and the Microsystems Engineering PhD program.

To assist with the preparation of the dissertation, students are encouraged to refer to the AIP, ACS, or IEEE style guides (referenced earlier). These guides provides useful information regarding getting started, writing style, word usage, grammar, words and phrases to avoid, and the key components of a technical paper.

Format of the Dissertation

A dissertation manuscript typically has three main components: (1) everything before the main text (the "front matter"), (2) the main text, and (3) everything after the main text (the "back matter"). Front matter for all Microsystems Engineering PhD dissertations, including the cover page, approval page, and abstract, should conform to standards accepted by the Institute which can be found at :

http://www.rit.edu/kgcoe/microsystems//forms/Docs/Microsystems%20Dissertation%20Title%20Pages.pdf

Additional pages such as acknowledgements, dedication, and nomenclature should follow as appropriate. If included, these pages should be in the order listed. The table of contents, list of figures, and list of tables should be placed between the dedication and the nomenclature. The main text of the dissertation should be divided into chapters which should cover the following sections:

1. Introduction
2. Background (or Theory)
3. Approach
4. Results
5. Conclusions and Recommendations

In most cases, these sections should be tailored to the research project and results. You need not always use these names for the various sections, but whatever format used, it must result in a better

presentation than would be possible by adhering to that suggested. The back matter should contain the references, the appendices and an optional author's biography.

Formatting the Manuscript

The following are guidelines for Ph.D. dissertation manuscript formatting.

1. Margins (letter sized paper, 8.5"x11")
   Top edge: 1"
   Left edge: 1.5"
   Right edge: 1"
   Bottom edge: 1"
2. Page Numbering
   - The title page is considered to be page "i", but the number is not typed on it.
   - All of the front matter pages are numbered consecutively in lower case Roman numerals placed to the center of the page, 3/4" from the bottom edge.
   - The first page of the main text (i.e. the Introduction section) is numbered "1" and all subsequent pages are numbered consecutively.
   - Page numbering of the back matter should continue consecutively from the numbering of the main text.
3. Spacing
   Paragraphs should double spaced, no indentation of the first line, left justified, and with a hanging indent of 0.5 inch for each paragraph. Headings may be centered or left-aligned; do not fully justify or right-align headings. Single-spacing is allowed for footnotes, endnotes, references, lengthy quotations, bulleted or numbered lists, figure or table captions, or material in an appendix.
4. Fonts
   - Times Roman font is recommended. Script and ornamental fonts will not be accepted.
   - Font size should be from 11 or 12 point. Font size should remain consistent throughout the front matter and main text and must be easily legible.
   - Fonts for footnotes, figure captions, table data, references, and material in an appendix or biography are allowed to differ from the main text but style should be compatible.
4. Headings
   - The font size and style chosen for chapter titles must remain consistent for the titles of all chapters and chapter equivalents.
   - Headings may be centered or left-aligned.
   - Heading levels must be differentiated from each other. That is, a main-level heading within a chapter must be made readily distinguishable from a sub-level heading within the same chapter by changing alignment (left or center) or capitalization or using a boldface or italic font or through the combination of any of these.

EXAMPLE HEADINGS

CHAPTER 1. THIS IS A CHAPTER TITLE

1.1 THIS IS A MAIN-LEVEL HEADING

1.1.1 This is a Sub-level Heading

1.1.1.1 This is a secondary sub-level heading

OR

CHAPTER 1. THIS IS A CHAPTER TITLE

1.1 THIS IS A MAIN-LEVEL HEADING

1.1.1 This is a Sub-level Heading

1.1.1.1 This is a secondary sub-level heading

A section must not have a sub-level heading without first having a main-level heading. Single sub-levels should be avoided. Headings that occur at the bottom of a page (without at least one line of text below the heading) should be moved to the top of the following page.

5. Figures and Tables
   - All figures, tables, and other illustrative material must fit within the minimum margins. Manuscript with any material extending beyond these margins will not be accepted.
   - Figures and tables must be numbered consecutively throughout the entire thesis. Format may be either a straight sequence (1, 2, 3, etc.) or the decimal system (1.1, 1.2, 1.3, 2.1, 2.2, etc.).
   - Figure numbering should be separate from table numbering.
   - Figures should be labeled using the fully typed capitalized word “Figure 1” and tables should be numbered with the fully typed capitalized word “Table 1” and so on.
   - Figure captions should be single-spaced and are not required to be set in the same font style or size as that of the main text. However, font style and size must remain consistent from one figure caption to the next.
   - Figure captions should appear on the same page as the figure to which they refer.
   - Figures should not be placed out of the order in which they are numbered.
   - Multiple figures may be placed on the same page as long as doing so does not compromise their legibility.
6. References

   Number citations consecutively in square brackets [1]. The sentence punctuation follows the brackets [2]. Multiple references [2], [3] are each numbered with separate brackets [1]–[3]. When citing a section in a book, give the relevant page numbers [2]. In sentences, refer simply to the reference number, as in [3]. Do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] shows ... .” Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it is cited; do not put footnotes in the reference list (endnotes). Use letters for table footnotes. Placing references at the end of this document are in the preferred referencing style. Give all authors’ names; do not use “et al.” unless there are six authors or more. Use a space after authors' initials. Papers that have not been published should be cited as “unpublished” [4]. Papers that have been submitted for publication should be cited as “submitted for publication” [5]. Papers that have been accepted for publication, but not yet specified for an issue should be cited as “to be published” [6]. Give affiliations and addresses for private communications [7]. Capitalize only the first word in a paper title, except for proper nouns and element symbols. For papers

published in translation journals, please give the English citation first, followed by the original foreign-language citation [8].

EXAMPLE REFERENCES

[1] G. O. Young, “Synthetic structure of industrial plastics (Book style with paper title and editor),” in Plastics, 2nd ed. vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15–64.

[2] W.-K. Chen, Linear Networks and Systems (Book style).Belmont, CA: Wadsworth, 1993, pp. 123–135.

[3] H. Poor, An Introduction to Signal Detection and Estimation. New York: Springer-Verlag, 1985, ch. 4.

[4] B. Smith, “An approach to graphs of linear forms (Unpublished work style),” unpublished.

[5] E. H. Miller, “A note on reflector arrays (Periodical style—Accepted for publication),” IEEE Trans. Antennas Propagat., to be published.

[6] J. Wang, “Fundamentals of erbium-doped fiber amplifiers arrays (Periodical style—Submitted for publication),” IEEE J. Quantum Electron., submitted for publication.

[7] C. J. Kaufman, Rocky Mountain Research Lab., Boulder, CO, private communication, May 1995.

[8] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interfaces(Translation Journals style),” IEEE Transl. J. Magn.Jpn., vol. 2, Aug. 1987, pp. 740–741 [Dig. 9th Annu. Conf. Magnetics Japan, 1982, p. 301].

7. Appendices
   - The appendix is a section that is placed near the end of the thesis and may contain material such as tables, figures, photographs, raw data, computer programs, and many other types of material that detract from the continuity of the main text or are too lengthy.
   - The appendix title should be formatted like a chapter title and headings should be formatted in a manner consistent with headings found in the main text.
   - Material in an appendix may be single-spaced to conserve space as appropriate.
   - If there is more than one appendix, they should be numbered as A, B, C, and so on. Each appendix should be started on a new page.

THE DISSERTATION EXAM (THE PH.D. DISSERTATION DEFENSE)

The dissertation defense can be scheduled only after all other requirements for the degree have been successfully completed. The student is expected to adhere to all requirements of the Ph.D. Dissertation Defense. The student, after making arrangements with his/her advisor and advisory committee, should work with the program office to schedule of the final examination of the dissertation by forwarding the title and abstract of the dissertation and the preferred date and time of the defense. The necessary schedule request form can be found on the program's web site. The final examination of the dissertation should not be scheduled sooner than six months from the date on which the student schedules the Research Review Milestone Meeting and no less than one year of the date on which the student passed the Candidacy Exam. Barring rare and exceptional circumstances (requiring permission from the program director), the examination may not be scheduled sooner than four weeks after formal announcement via hallway postings and email broadcast.

Preliminary Steps

When you and your advisor have agreed that you are ready for the defense of your dissertation, you should submit copies of your draft dissertation manuscript to all committee members and the program director. You should expect that there could be considerable re-writing after this draft submission. You should allow at least three weeks for your committee members to read the manuscript and comment. Depending on the nature of the comments, you will need to plan sufficient time for revising. It is in your interest to keep in very close contact with all committee members so you can anticipate their remarks and accommodate them as much as possible during this revision stage. The program director may provide feedback on the content as well as format. Thus the draft copy should conform to all the regulations regarding the dissertation manuscript presentation.

Scheduling the Defense

After revisions, you should re-submit the manuscript to the committee members and set up a convenient date for your defense. The program director must also be consulted. The proposed defense date cannot be earlier than four weeks from the approval by your advisor and committee of your revised draft manuscript. It is your responsibility (not your advisors) to contact your committee to schedule all arrangements, which may include travel for some members. In the event that a committee member is not able to travel for the defense, the scheduling of teleconferencing, video conferencing, or web conferencing is an option. It is also your responsibility to post announcements (by email and via hallway) and this should be done with at least four weeks' notice of the defense. The announcement should contain details about the dissertation; the defense time, date, and location; an abstract; a brief biography; and an appropriate figure if desired. The email broadcast of the announcement should be coordinated with the Ph.D. program office. The thesis examination will be held at RIT at a location that is convenient to the committee members and the targeted audience. In order to graduate and attend commencement in a given academic year, the defense date must be agreed upon by the student, advisor, committee, and program director no later than April 15 of that year.

The Exam Process

The first part of the examination is open to the public and advertised in advance. It comprises a presentation and is primarily a defense of the dissertation research in the form of a seminar, with visual aids as appropriate. It is expected to be completed within one hour, with approximately 45 minutes of presentation followed by 10 minutes for questions. During the talk, the following points must be addressed: objectives and accomplishments of the research; what is the problem; why is it relevant; what approach was taken and why; and what were the results and conclusions. It is expected that the candidate will make a verbal presentation with only occasional reference to written notes. After the end of the presentation, the committee will examine the candidate in a closed meeting. The program director will also attend. The examination is primarily concerned with the research dissertation work, but it is also of the nature of a final certification of the student's overall knowledge for the degree. Questions may relate to any aspect of the material in the research area and in the coursework of the degree program. The examination lasts about one hour or more, at the end of which the candidate will be asked to leave the examination room while the committee discusses the exam and their decision. After a decision has been reached, the candidate is invited back into the room. In the case of failure, the candidate will be advised as to what actions can be pursued.

Signatures and Copies

Upon successful completion of the examination, the necessary signature pages of each copy of the dissertation manuscript are signed by the appropriate persons. Original signatures must be on all copies. Securing the signatures is the student's responsibility and it is done once final revisions to the dissertation manuscript are accepted. Additional information regarding manuscript hard copies is available from the program office.

PUBLISHING THE DISSERTATION

There are several requirements and guidelines pertaining to the publication of the dissertation manuscript. All copies should be high quality and it is the student's responsibility to make arrangements for copying. The bound spine title will include the title, the author's last name and the year of acceptance for degree requirements and total no more than 96 characters in length (including spaces). If your title is longer than 96 characters, please create an abbreviated title that will be used for the spine only. You are responsible for making copies of your dissertation for binding. Collate, separate and clearly identify each copy before you bring them to the Library. Costs associated with copying are the responsibility of the student. Students should consult with their advisor for assistance with copying costs.

Copyright Law and Graduate Research

The graduate student thesis is copyright protected material and some familiarity with copyright rules and responsibilities is a good idea. Copyright law establishes certain rights and ownership to the creator of original art, text, figures, etc. Additionally, during the course of research and publication, the meaning of "fair use" and "copyright infringement" should be understood. Copyright law will become increasingly important throughout a students academic as well as professional career. Students should read and understand the materials on Copyright Law and Graduate Research available from RIT's Publishing and Scholarship Support Center.

Preparation of the Dissertation for Binding and Publication

Once you receive final approval from your committee and all necessary copies are made, follow the following procedures to submit your dissertation for binding:

a. Arrange for binding of dissertation manuscript copies with the program office. You are generally responsible for paying the binding fee for any copies other than those requested by your advisor and your dissertation committee.
b. If an embargo (a hold on publishing) is needed, fill out the necessary form and submit it to the Dean of Graduate Studies.
c. Make an appointment with the Thesis Binding Office in the Wallace Library (http://library.rit.edu/depts/assets/thesisbindingform/apptRequestAllDays.php) to deliver your receipt, copies, and any CD-ROMs and signed embargo form, if applicable. Before submitting, please have all your copies properly collated with all signature pages inserted and also identify copies as needed.
d. Submit your thesis/dissertation to ProQuest/UMI at http://www.etdadmin.com/rit following the submission guidelines. If you chose the Open Access Publishing option, you may be responsible for paying an additional fee. A PDF version of your thesis must be submitted to ProQuest/UMI for either Traditional or Open Access Publishing. Remember to exclude signatures from the electronic version of your paper. Forward the confirmation response received from ProQuest to the program office.

Additional detailed information regarding ProQuest/UMI submission can be found at:
http://infoguides.rit.edu/thesis-services

The binding of your thesis/dissertation copies takes approximately 2-4 weeks. Bindery shipments are sent and received on alternate Thursdays. The designated pickup person will be notified when your copies return from the bindery. The RIT Archive's copy will be catalogued in Einstein (RIT Libraries Catalog), World Cat, and shelved in the RIT Archives.

DEGREE CERTIFICATION

Certification will be carried out once all requirements of the Ph.D. program are met, including binding of the dissertation manuscript.

ADDITIONAL INFORMATION

All RIT policies and regulations apply in full to the Microsystems Engineering PhD program. The Institute Policies and Procedures manual can be found at http://www.rit.edu/~w-policy/alpha.shtml This manual provides the general and educational policies and procedures of the Institute, including information related to students, faculty, staff, and administrators as well as the vision and goals of the Institute. A few of the RIT and Microsystems Engineering policies are given here to provide guidance for the student.

Student Records

Student records are housed in the Kate Gleason College of Engineering and in the Microsystems Engineering PhD program office. Administrative support is available to students through this office in areas of registration, course selection, scheduling, records, and program advisement. In

accordance with the Family Educational Rights and Privacy Act of 1974 (commonly known as the Buckley Amendment), RIT students have the right to inspect, review and challenge the accuracy of official educational records. RIT policy ensures that only proper use is made of such records. With the exception of copies made for internal use (provided by the registrar for advising purposes), copies of a student's permanent record (transcript) or non-public information from student records will not be released without the student's written consent. Official written requests from students must be made for transcript release.

RIT's Continuation of Thesis / Dissertation Policy

If a student has completed thesis/dissertation course work but has not finished the thesis/dissertation itself, it is the responsibility of the student to register each semester for a one credit hour Continuation of Thesis/Dissertation course. The program may offer students one semester extension of time before the Continuation of Thesis/Dissertation tuition is levied. For the semester in which the Continuation of Thesis/Dissertation tuition is not to apply, the student will register for "0" hours.

Once work has begun on a thesis/dissertation, it is seen as a continuous process until all requirements are completed. It is the student's responsibility to register each semester for a one credit hour Continuation of Thesis/Dissertation course if the student has completed the program thesis course work but not the thesis itself. Students will be responsible to register each semester and pay one credit hour of Continuation of Thesis/Dissertation tuition after they have completed the thesis/dissertation credits required by their program. If the student does not register for the Continuation of Thesis/Dissertation course for one semester hour of credit, the program may either:

a) Register the student for "0" credits (using a drop/add form) for which no tuition is assessed in order to maintain registration for one semester only, excluding summer, or
b) Remove the student from the program