

Master of Science in Sustainable Engineering

Graduate Manual

RIT

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Part 1: General Program Information

Part 1 of this graduate manual is primarily intended for students interested in learning more about the Masters of Science (MS) in Sustainable Engineering. An introduction to the program, admission requirements, and information on graduate assistantship as well as scholarship is provided in this section of the manual.

1. Master of Science Degree in Sustainable Engineering

Sustainable Engineering refers to the integration of social, environmental, and economic considerations into product, process, and energy system design methods. Additionally, sustainable engineering encourages the consideration of the complete product and process lifecycle during the design effort. The intent is to minimize environmental impacts across the entire lifecycle while simultaneously maximizing the benefits to social and economic stakeholders. The MS in Sustainable Engineering is multidisciplinary and managed by the Industrial and Systems Engineering (ISE) Department.

The Master of Science program in Sustainable Engineering builds on RIT's work in sustainability research and education, and offers students the flexibility to develop tracks in areas such as renewable energy systems, systems modeling and analysis, product design, and engineering policy and management. Coursework is offered on campus and is available on a full-time or part-time basis.

2. Admission Requirements

Admission to the Sustainable Engineering graduate program is determined based on the full evaluation of the application and accompanying material including undergraduate degree program, transcript, GPA, GRE scores, TOEFL scores (if required), letters of recommendation, and statement of purpose. The GRE is required for all students applying to the MS program.

Although applications may be submitted at any time, to be sure that your application will receive full consideration for admission to RIT in the fall semester of the next academic year, the following deadlines should be observed:

Application Timeline for Fall Semester:

January 15: All application materials must be received

March 31: Notification of admission decision/graduate assistantship decision

The general entrance requirements consist of a BS degree in engineering, technology, mathematics or science, and a minimum equivalent cumulative undergraduate GPA of 3.00/4.00. Minimum TOEFL scores of 580 (paper-based) or 90 (Internet-based) are required for students that do not have English as their first language. For students without an engineering degree, some bridge coursework in the basic engineering sciences may be necessary prior to full admission.

3. Graduate Assistantships and Scholarships

Application for Graduate Assistantships and Scholarships can be made by checking the appropriate box on the RIT Graduate School Application indicating interest in an assistantship. Applications received before January 15, will be given priority for assistantships to be awarded for the following academic year. *Only full-time MS students will be considered for assistantships.* Departmental graduate assistantships may be awarded to new students for the current academic year on a competitive basis that depends on the current graduate student population, the number of applicants, and the strength of the graduate student application. Graduate assistantships awarded to new students are only guaranteed for the designated enrollment date. **If a student elects to defer admission, the student must reapply for a graduate assistantship.** Graduate assistantships for continuing students will be evaluated on a semester basis. These assistantships will be awarded on a competitive basis based on progress toward the degree including courses taken, GPA, progress toward thesis, endorsement of advisor, and performance of current assistantship duties. Departmental support for graduate students is limited to two years from the start of enrollment.

Part 2: Information for Students in the MS Sustainable Engineering Program

Part 2 of this manual includes important information for students that have entered the MS Sustainable Engineering program. This includes student expectations, graduation requirements, thesis information, and co-op information. Following this section are two important appendices.

1. Graduation Requirements

The MS degree will be awarded upon successful completion of a minimum of 30 credits that is equivalent to 8 courses and 6 credits of thesis research. *All MS students are also required to complete the Graduate Thesis Seminar course sequence (ISEE 795 and ISEE 796).*

1.1 Plan of Study

The Sustainable Engineering Graduate Program Director initially serves as a student's advisor to select courses. **Prior to the completion of the first semester, the student's plan of study must be mapped out with and approved by the student's thesis advisor using the appropriate plan of study form in Appendix B.** An approved plan of study must be submitted to the ISE office to be placed in the student's department file. Any updates to the plan of study in future terms require a new plan of study form to be completed and submitted to the ISE office.

The MS degree requires that students complete a minimum of 30 credits of study consisting of at least 8 three-credit courses, the two-course sequence of ISE Graduate Seminars, and 6 credits of thesis research. (See Section 2 for thesis requirements.)

The coursework must meet the following requirements:

- **The following required courses:**
 - ISEE-771 Engineering of Systems I
 - ISEE-785 Fundamentals of Sustainable Engineering
 - ISEE-786 Lifecycle Assessment
 - MECE-629 Renewable Energy Systems
- **1 Social Context elective**
- **1 Technology elective**
- **2 Engineering electives**
- **The two course sequence of ISE Graduate Seminar:**
 - ISEE-795 Graduate Seminar I
 - ISEE-796 Graduate Seminar II
- **ISE Thesis Research - 6 credits**
 - ISEE-790 Research and Thesis

A list of potential graduate courses for meeting these degree requirements appears in the Appendix A. Please note that not all courses may be appropriate for all students/plans of study and must be approved by the thesis advisor through the plan of study approval process. Equivalent or more advanced courses in the list of core course areas may be substituted with the approval of the

advisor. In addition, special topics or independent study courses can be used to satisfy program requirements. This requires the consent of the Sustainable Engineering Graduate Program Director.

1.2 Institute Policy

In accordance with Institute policy, all graduate programs must be completed within seven years after taking the first graduate course(s) that applies to the program. Exceptions to the seven year rule require a petition to the Dean of Graduate Studies with an explanation as to why the student will be unable to complete the program within seven years. This request must be accompanied by a letter of from the Director of Sustainable Engineering Graduate Programs. The request must be made prior to reaching the seven year limit. Approval is not automatic.

2. Thesis Requirements

There are four main components of the thesis that will be described in this section: thesis advising information, the graduate seminar, the thesis proposal, and the thesis. Completing each of these items is a requirement for completion of the MS degree.

2.1 Thesis Advisor and Committee

The Sustainable Engineering Graduate Program Director initially serves as a student's advisor. **Prior to the completion of the first semester of study, the student must select a thesis advisor. In conjunction with the thesis advisor, the student must submit a plan of study as outlined in section 1.1.** The formation of the thesis committee is critical to the timely completion of the MS degree. **Prior to the thesis proposal defense, the student must form a thesis committee as follows:**

Step 1. The student should initiate the formation of their committee by selecting a primary thesis advisor from among the ISE Faculty (Professor, Associate Professor, or Assistant Professor) based upon the student's interests and the agreement of the new advisor. In the event that the thesis topic is interdisciplinary, the student may select a second primary advisor from among RIT faculty within or outside of the ISE Department. These two individuals would then serve as co-advisors to the student, with approval from the Sustainable Engineering Graduate Program Director.

Step 2. The student should then, in conjunction with their advisor, form a thesis committee. The committee should be comprised of at least two RIT faculty members (Professors, Associate Professors, or Assistant Professors) including the advisor. The remainder of the committee may consist of RIT faculty (including instructors or lecturers) or industrial personnel from outside RIT.

Note: In the unlikely event that the need arises for a student to change the composition of their committee; the student should submit written justification signed by all previous committee members to the ISE Department and previous committee members. The student should follow Steps 1 and 2 to re-form their committee.

2.2 Graduate Seminars

To aid students in the development of a thesis topic and proposal, students will complete the following two course sequence of seminars, Graduate Seminar I (ISEE-795) and Graduate Seminar II (ISEE-796). The seminars introduce students to research methods in industrial and systems engineering and sustainable engineering, while presenting state of the art research in those disciplines.

The two-course sequence is designed to promote discussion and interaction on ISE and sustainable engineering research topics and to present research methods such as conducting critical reviews of research literature, initiating background research on a thesis topic, and preparing a formal thesis proposal. The seminar will include invited speakers from within and outside of RIT to present their research work and to promote discussion, cultivate ideas, and promote research. The dates for the seminar speakers will be announced and attendance by all MS Sustainable Engineering students is required.

At the conclusion of the first course students are expected to have identified a thesis topic, completed a critical literature review, and have written an introduction for the thesis proposal. At the end of the second course, students are expected to have completed and submitted a formal thesis proposal.

2.3 Thesis Proposal

A thesis proposal is a document that each MS Sustainable Engineering student will develop to propose to their thesis committee. The proposal describes the research problem that they plan to investigate, the problem scope, a critical literature review, and a planned methodology. The purpose of the thesis proposal is to ensure that the student has defined a sufficient problem for the MS degree; the scope of the problem can be completed in a reasonable amount of time (typically 9-12 months); the student has a sufficient understanding of previous work to date; and that the methodology proposed can be implemented by the student with the resources available to RIT.

The student will hold an oral defense of their thesis proposal to their thesis committee. The thesis proposal defense date will be mutually agreed upon by the student and the committee members. The student should submit the thesis proposal document to the thesis committee at least 2 weeks prior to thesis proposal defense. The committee members will each complete a thesis proposal rubric and will come to a mutual agreement on the overall thesis proposal outcome.

The student should submit the approved thesis proposal signed by all committee members to the ISE office. This should be completed at least 6 months prior to the student's expected thesis defense date. Once a thesis proposal has been successfully defended and accepted by the committee, requests to change the scope of work will generally not be granted. In the event a change in scope is required, the student must submit a formal document detailing the changes to all committee members. Once all committee members have approved and signed the document, the student should submit the document to the ISE office.

2.4 Thesis

The thesis student should obtain approval from their thesis advisor when both the student and the advisor mutually agree the student has completed all of the work outlined in the thesis proposal. A thesis is a document that describes the thesis research problem, the problem scope, a thorough and critical literature review, a methodology, results of the methodology, conclusions, and suggestions for future research. Students are strongly encouraged to prepare the thesis in a format suitable for publication in a refereed journal prior to thesis defense.

The student should submit a complete copy of their thesis to the committee at least four weeks prior to the thesis defense. The student should schedule a mutually agreeable time to hold an oral defense of the thesis with all committee members. The oral defense of the thesis is conducted in front of the thesis committee and will be open to the Institute.

Students are encouraged to work with their advisor, the Sustainable Engineering Graduate Program Director, and the ISE office staff to find a suitable room and time to defend the thesis. The student must submit the following information to the Sustainable Engineering Graduate Program Director two weeks prior to the oral thesis defense date: title of the thesis, thesis abstract, thesis committee members, thesis room, date, and time. This information will be announced and publicized prior to the defense date.

At the oral defense of the thesis, the student's thesis committee will judge the thesis using the following options: pass, conditional pass, adjournment, or failure. Pass means the thesis has been successfully defended and the document is accepted in its current format. Conditional pass means that the thesis defense was successful, however, some revisions to the work presented in the thesis document must be made prior to the thesis committee accepting the document. Adjournment means that the thesis defense and document were not adequate to warrant a pass, but the student may make the changes required by the thesis committee and re-defend the thesis. The adjournment options require revisions to the thesis document as well as another oral defense and the student must proceed with the above outlined procedures for scheduling the defense. Failure means that the thesis committee has rejected the thesis. The committee decided upon a failure if they feel the student has not adequately defended the thesis, the thesis research is not sufficient, and/or the thesis document is not satisfactory. If the committee rejects the thesis, the student should explore non-thesis degree options (e.g., Master of Engineering degree).

Once the thesis has been successfully defended and all revisions have been completed, the student should submit bound and appropriately formatted copies of their thesis to the ISE Department and each committee member (if they request a copy). An electronic copy of the thesis is also required to be submitted to the library for placement in the RIT Digital Media Library. **For additional information on thesis binding and electronic submission of the thesis please see: <http://infoguides.rit.edu/thesis-services>.** The e-mail verification of electronic submissions should be given to the ISE department as proof of completion and eligibility of certification.

3. Student Expectations for Graduate Assistantships and Scholarships

The ISE Department is fortunate to be able to provide a number of graduate scholarships and assistantships to Master of Science students, and tries to be as generous as possible in funding graduate students to study at RIT. From the perspective of the ISE Department, this funding is an investment in graduate students and the research work that students will produce while working with the ISE faculty.

The expectation for students receiving scholarships and assistantships includes (but is not limited to) the following:

- Being present at RIT during the academic semesters including the weeks of exams and excluding official institute breaks (between semesters, winter break, etc.). The RIT academic calendar is announced well in advance of each academic year. Students must consult this when making travel reservations, etc.
- Attend and perform well in classes. Students must maintain a minimum GPA of 3.00 to remain in good academic standing.
- Make good progress towards completing the degree program within two academic years by taking classes, establishing a thesis topic, establishing a thesis advisor and committee, submitting a plan of study, submitting a thesis proposal, etc.
- Behaving in an ethical manner inside and outside of class.

The additional expectations for students receiving assistantships include (but are not limited to) the following:

- Working the scheduled time according to your assistantship (e.g. 10 hours/week). In some cases, such as teaching assistantship assignments, the work may vary from week to week, but should average out to this quantity over the semester.
- Report regularly to the faculty advisor administering the assistantship.
- Perform work to the best of your ability and meet due dates for assigned tasks.

Graduate students should be aware that not fulfilling the expectations of graduate assistantships may result in a corresponding reduction in scholarships and assistantships. Furthermore, the items outlined above will be taken into account when evaluating graduate scholarship and assistantship awards in future semesters.

The ISE Department desires to have the best department possible, and graduate students are essential to making this happen. We appreciate the hard work graduate students and hope that they will benefit from this education and experience.

4. Cooperative Education (Co-op)

Cooperative education (Co-op) is an optional part of the ISE graduate programs. Co-op is a paid work experience at a company designed to help educate students through the application of academic course material in a work environment. If a graduate student elects to pursue a co-op position, the co-op must be done as an integral part of the plan of study for the graduate degree program.

Communication with the faculty advisor about your intent to co-op is extremely important. You should have a discussion with your faculty advisor to determine how the co-op will be integrated into the degree program to ensure continued progress of your research and the effect on your expected graduation date (if any).

The RIT Office of Career Service and Cooperative Education has a process that students must follow to enroll in co-op. This includes attending a Co-op Prep Session before using their services. This Co-op Prep Session is typically held a group session for ISE Department degree programs (date and time will be announced).

For international students, additional co-op rules and guidelines may apply and are available through the International Student Services Office.

Appendix A: Potential Graduate Courses

The list of potential courses below represents courses that will earn credit as valid graduate courses. **It is required that you complete a plan of study approved by your advisor even if the courses you plan to select appear on the approved list.** The Sustainable Engineering Graduate Program Director will continue to entertain other courses on a case-by-case basis. Courses will only be accepted if the student has discussed the choice with his/her advisor and received permission from the advisor in writing. Students should not assume that a graduate course deemed appropriate for one will be appropriate for all.

Engineering Electives

- ISEE-601 Systems Modeling and Optimization
- ISEE-610 Systems Simulation
- ISEE-626 Contemporary Production Systems
- ISEE-640 Computer-Aided Design & Manufacturing
- ISEE-660 Applied Statistical Quality Control
- ISEE-661 Linear Regression Analysis
- ISEE-682 Lean Six Sigma Fundamentals
- ISEE-684 Engineering and the Developing World
- ISEE-701 Linear Programming
- ISEE-702 Integer and Nonlinear Programming
- ISEE-703 Supply Chain Management
- ISEE-704 Logistics Management
- 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
- ISEE-732 Systems Safety Engineering
- ISEE-740 Design for Manufacture and Assembly
- ISEE-741 Rapid Prototyping and Manufacturing
- ISEE-745 Manufacturing Systems
- ISEE-750 Systems and Project Management
- ISEE-752 Decision Analysis
- ISEE-760 Design of Experiments
- ISEE-772 Engineering of Systems II
- ISEE-787 Design for Environment
- ISEE-789 Special Topics
- ISEE-799 Independent Study
- MCEE-620 Photovoltaic Science & Engineering
- MECE-606 Systems Modeling
- MECE-650 Sustainable Energy Use in Transportation
- MECE-731 Computational Fluid Dynamics
- MECE-733 Sustainable Energy Management
- MECE-738 Ideal Flows
- MECE-739 Alternative Fuels and Energy Efficiency
- MECE-744 Nonlinear Control Systems
- MECE-751 Convective Phenomena
- MECE-754 Fund. of Fatigue and Fracture Mechanics

Social Context Electives

- ECON-620 Environmental Economics
- ECON-810 Economics of Sustainability
- ENVS-631 Climate Change: Science, Technology & Policy
- INTB-730 Cross-Cultural Management
- MGMT-710 Managing for Environmental Sustainability
- PUBL-610 Technological Innovation & Public Policy
- PUBL-630 Energy Policy
- PUBL-631 Climate Change: Science, Technology & Policy
- PUBL-789 Special Topics (requires prior approval)
- PUBL-810 Technology, Policy, & Sustainability
- STS0-750 Graduate Sustainable Communities

Technology Electives

- ESHS-613 Solid & Hazardous Waste Management
- ESHS-614 Industrial Wastewater Management
- ESHS-615 Air Emissions Management
- ESHS-720 Environmental Health & Safety Management
- ESHS-725 EHS Accounting & Finance
- ESHS-755 Corporate Social Responsibility
- ESHS-765 Product Stewardship
- PACK-730 Packaging and the Environment

Appendix B: Plan of Study

Master of Science in Sustainable Engineering (SUSTAIN-MS) Plan of Study

Name: _____

RIT ID: _____

Address: _____

Ph(w): _____

Ph(h): _____

Email: _____

Entry Term: _____

7-Year Limit: _____

<i>Course</i>	<i>Semester</i>	<i>Grade</i>	<i>Credits</i>
1. ISEE-771 Engineering of Systems I			3
2. ISEE-785 Fundamentals of Sustainable Engineering			3
3. ISEE-786 Lifecycle Assessment			3
4. MECE-629 Renewable Energy Systems			3
5. Social Context elective			3
6. Technology elective			3
7. Engineering elective			3
8. Engineering elective			3
ISEE-790 Research and Thesis			6
ISEE-795 Graduate Seminar I			0
ISEE-796 Graduate Seminar II			0
Total			30

Thesis Title: _____

Proposal Submission Date: _____

Thesis Advisor: _____ Signature: _____ Date: _____

Committee Member (s): _____

Defense Date: _____

Completion Date: _____

* Course not required to fulfill degree requirements

Ending GPA: _____