UNIVERSITY OF GEORGIA

Engineering Education Transformations Institute

Graduate Handbook

PhD Area of Emphasis: Engineering Education and Transformative Practice (EETP)

Director of Graduate Studies: James L. Huff, james.huff@uga.edu

Graduate Program Administrator: Ann Marie Hormeku, ahormeku@ugu.edu

Director: Julie P. Martin, julie.martin@uga.edu

For the formal program description and requirements, see the College of Engineering website: Link to EETP Information & Requirements

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1 About this Graduate Handbook

This graduate handbook supplements but does not replace the guidelines offered by the College of Engineering Graduate Handbook and the University of Georgia Graduate Policies. Our goal with this document is to offer contextualized guidance for the EETP Ph.D. program, which uses a highly interdisciplinary curriculum involving an integration of engineering disciplinary contexts and social scientific theories and methodologies. If one perceives a conflict between guidance offered here and any of the aforementioned documents, they should reach out to the EETP Ph.D. Director of Graduate Studies for guidance on how to interpret the guidance offered here.

2 Studying Engineering Education and Transformative Practice (EETP) at UGA

2.1 What is Engineering Education Research?

Engineering professions have played a significant role in the socio-economic developments of civilizations and human explorations. Engineers use logical, analytic, and creative skills to translate scientific theories into products and processes that facilitate innovation and revolutionize the way we live our lives. Engineering fields fundamentally affect all aspects of our civic and economic lives. Therefore, maintaining a vibrant engineering workforce is strategically important for the economic and security well-being of advanced and developing nations today. Just as engineering is integral to national development, so is the training and education of engineering students. Society and industries expect engineering students to have acquired the intellectual, social, and ethical capacity they need to integrate into the engineering workforce upon graduating from engineering programs.

As an emerging field of inquiry, engineering education research focuses on creating knowledge that defines, informs, and advances the education of engineers from cradle to grave, both in formal and informal settings. During your doctoral program, you will be equipped to conduct research that advances innovative pedagogies for engineering education, explores a variety of pathways for achieving an inclusive engineering workforce. In addition, your research training will expose you to educational, sociological, and psychological theories and research methodologies that will prepare you for cutting-edge research in engineering education.

The engineering education research field draws upon multiple inquiry methods that facilitate the interdisciplinary exchange of ideas between educators and engineers in creating knowledge that has a significant national impact. Furthermore, the engineering education research enterprise is growing rapidly with significant funding opportunities for addressing contemporary local and global challenges. The EETP Ph.D. program prepares you to participate in any of the major research areas of the engineering education enterprise and to contribute to the advancement of the engineering discipline.

2.2 Why pursue a PhD in Engineering Education and Transformative Practice (EETP) at UGA?

The EETP Ph.D. program, offered by the University of Georgia's Engineering Education Transformations Institute (EETI), prepares doctoral students who want to specialize in engineering education a PhD experience that in every way is comparable, but also unique, to those offered by other engineering education PhD programs across the United States. Unlike many other engineering education programs that are situated within a departmental unit, EETI is purposefully situated across the technical engineering schools at the UGA College of Engineering. As an EETP graduate student, you will be fully affiliated with the EETI educational research community. Hence, the uniqueness of the EETP program is grounded in EETI's objective to transform engineering education through building social capital and shared capacity and community around the scholarship of teaching and learning in engineering directly in the College of Engineering.

This capacity and community building is also one of the core values to the EETP program and offers a unique PhD experience, which is explicitly designed to prepare future engineering education scholars for diverse career opportunities inside and outside of academia. The EETP's philosophy and guiding values (Section 3) speak to this aspect in more detail.

The EETI faculty are fully integrated within the various schools in the College of Engineering. As such, EETI faculty are structurally and deliberately situated within our engineering schools in a way that makes it easier, more effective, and goal-oriented to facilitate interdisciplinary collaborative research projects between the EETI and technical engineering faculty. Because of the structural organization and affiliation of our faculty with the engineering schools, EETP graduate students also find it easier to take both discipline-focused engineering and engineering education courses and to conduct interdisciplinary dissertation projects with technical components during their doctoral training. Our students are encouraged to enroll in relevant graduate learning theories, assessment, and research methodology courses in the Mary Frances Early College of Education and the McBee Institute for Higher Education (or other units across UGA) that are strategic to their dissertation and career objectives. These opportunities are also tailored to equip our doctoral students to participate nationally and internationally in the engineering education practice and research community.

3 Philosophy and Guiding Values

EETI's goal is to develop strong and empathetic contributors to the field of engineering education through their pursuit of a Ph.D. in Engineering Education and Transformational Practices. To this end, EETI aims to promote positive synergies between advisor and advisee(s) that:

1. *Commit to research excellence and impact:* Our faculty advisors are committed to facilitate and support the acquisition of the fundamental knowledge and research expertise that our students need to build a successful career in engineering education research or any related field. This includes the goal to have a positive impact on the engineering education research community and educational practice starting from the very first day of the EETP program.
2. *Support initiative and responsibility:* Our students have an important role in shaping the scholarship of teaching and learning in engineering education and practice. As such, we aim to cultivate a collaborative environment that empowers our students to develop top-notch programs of research and as partnership with others within the engineering research community.

3. *Provide flexibility and agency for advisees:* Our faculty advisors work with students to tailor a flexible program of study that is strategic to and reflects the research identity our students desire to cultivate within the engineering education community. We believe that Ph.D. students are supported best when they are given agency, initiative, and responsibility for their own program. Our advisors are committed to support this personal growth process by the students and, thus, help them to become an equal part of the research community at a local, national, and international level.
4. *Facilitate a collaborative research community:* We facilitate research groups and a research community that ensures collaborative engagement between engineering education and technical engineering faculty and students across the college of engineering.
5. *Support individualized student trajectories:* In recognition of the varied interests and career goals of Ph.D. students and the high variety of application fields for engineering education research expertise, EETP is designed to offer both a robust education in engineering education and research practice and the needed flexibility for Ph.D. students to tailor their own course program towards individual needs, interests, and future plans.

4 Admission

4.1 EETP Ph.D. Program Admission Requirements

All applicants must meet the admission requirements for the College of Engineering as specified in the "Admission to the College of Engineering" section of the Graduate Program Handbook, available at: https://www.engineering.uga.edu/graduate-program-handbook. All applicants are expected to possess a B.S. or M.S. degree in engineering, sciences, education, or a related field.

Students with an M.S. degree may contribute up to 30 relevant credits of their M.S. degree toward their EETP Ph.D. degree, reducing the number of new credit hours needed for graduation. Students without an M.S. degree are expected to work with their advisor to complete the coursework that provides the necessary grounding to ideally support their plan of study and research. For further details see information provided in Section 5. Additionally, applicants without an M.S. degree should clearly communicate in their Statement of Purpose why they believe a direct-to-Ph.D. graduate school experience is appropriate, given their experience and goals.

Given that engineering education is an interdisciplinary field, the EETP Ph.D. program also accepts applications from students with backgrounds in non-engineering disciplines. Students with degrees in non-engineering, natural sciences, or technical disciplines are expected to work with their advisor to complete coursework that provides the necessary engineering grounding to support their proposed plan of study and research. This grounding may, for example, consist of 12 credit hours focused on one of the following four areas: Engineering Design; Engineering Professionalism; Engineering Science; and Engineering Technology. Prerequisites for courses across these areas can be waived, as needed and appropriate, by the Director of Graduate Studies. For more information on this process, see Appendix A.

4.2 EETP Ph.D. Program Application Process

Identifying a potential major professor (advisor)

The selection of the major professor is one of the most crucial and formative steps in a student's graduate experience. Hence, identifying a potential major professor should be the first step in the application process. In line with EETI's commitment to a collaborative and formative approach to the graduate program, we will use term *advisor* to reflect the mentoring nature of this partnership between a major professor and a student. Prospective students are encouraged to read works by several faculty members to explore the alignment between the student's research interests and faculty members' research programs. Students should contact faculty members prior to applying determine if the faculty member has the ability to fund new students, and to explore potential fit with their research interests.

While prospective students should reach out to potential advisors in advance, decisions about acceptance into the EETP program will only occur after the deadline for applications has passed. Acceptance will generally include an offer of full funding and pairing between the prospective student and advisor. In most cases, the financial funding is connected to a single advisor. If a prospective student expresses interest in working with EETI faculty member who cannot support them, the graduate admissions committee will share their application with other prospective faculty advisors who could serve as the student's major professor.

Applying to the Program

Students who wish to apply to the EETP Ph.D. program should follow the application process detailed on the UGA College of Engineering Website, which contains all relevant application information, materials, and instructions: https://www.engineering.uga.edu/graduate-programs/admissions.

Part of this process includes writing a *statement of purpose*, which should include the following details:

- Your goals for pursuing graduate study in the EETP program. What do you hope to do upon graduation, and how will the EETP program help you reach these goals?
- Descriptions of your prior research experiences, and how you believe these experiences impact your trajectory and fit in the EETP program.
- The name of at least one faculty member with whom you are interested to work, and why.
- If you are applying without a master's degree in an engineering or related field, please specify why you believe a direct-to-Ph.D. graduate school experience is a good fit for your goals and strengths.

5 Curriculum, Assessment, and Advising

Building on the guiding values discussed in Section 3, the following sections lay out the principles, processes, and key milestones for a graduate student's progression through the program. These policies are grounded in UGA's and the College of Engineering's Graduate Handbooks and provide discipline-appropriate specificity. Students are encouraged to closely review both

documents and ensure compliance with them as they provide the policy framework for the EETI Graduate Handbook.

Figure 1 provides an example timeline (based on 4-5 year program plan) and overview of the key milestones for a student's coursework and research trajectories. Subsequent sections provide details for each milestone.

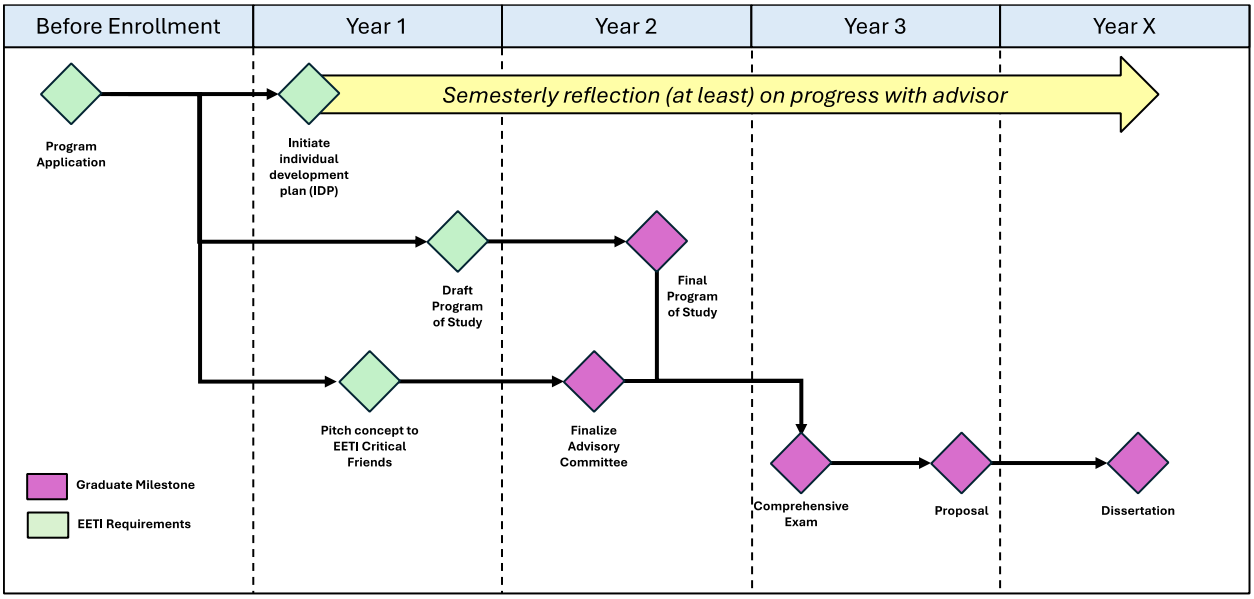

Figure 1: Example timeline and key milestones (represented as blue diamonds)

5.1 Laying the foundation for a healthy student/advisor relationship

Contacting and coming to an agreement with a major advisor marks the first important milestone in each PhD program timeline. This step is part of the admission process and, hence, discussed above in Section 4.

EETI faculty conceptualize the relationship between the advisor and the student as a partnership in learning between an experienced researcher and a future colleague in the field. This definition has significant implications on the responsibilities of both partners:

- For the student, the understanding assumes a commitment to learning, community building, professionalism[1], and excellence in research and instruction. In the usual case where a student is funded through one of the advisor's research grants, a meaningful and substantive contribution to the overall project is expected from the student, an effort that should be aligned with and further the student's dissertation journey and development as a professional.

[1] EETI has an inclusive view of professionalism that includes treating all colleagues, including faculty, staff, and students with respect; conducting research in ways that "do justice" (Sochacka et al., 2018) to all stakeholders involved in the research process; developing and maintaining strong communication and time management skills; and a commitment to developing as an independent researcher. Our conception of professionalism does *not* include expectations concerning students' appearance, mannerisms, or speech.

- For the advisor, it implies a focus on and commitment to the student's individual professional development as a researcher, educator, and member of the broad engineering education community.

To support this partnership, the policies laid out here aim to maximize the team's flexibility and agency in crafting each individual graduate's journey. Guided by the above characterization of the advisor/advisee relationship, advising activities are central to students' professional development and the achievement of the team's goals.

To support an advising approach that accounts for the individual student's needs, the following provides a structured process for collaboratively developing an *individual development plan (IDP)* and implementing a regular, semesterly *reflection and review process*. With the goal of providing a consistent experience, the IDP and review process is required for all graduate students. Advisor/student teams are encouraged to adapt and adjust the suggested frameworks to accommodate a student's individual needs and goals.

The IDP and the Reflection and Review Process are intended to be professionally developmental and individually supportive. The focus of the shared activities should be on reflection, purposeful growth, and productive accountability without constituting a merely evaluative or formal process. In this sense, these mechanisms serve a dual purpose. First, the opportunity to articulate goals and expectations provides clarity for both the student and advisor as a basis for a productive, collaborative shaping of the dissertation journey. Second, EETI faculty believe that reflection is a key tool for developing and succeeding as a professional in any area, a notion that is supported by an abundant body of research. Reflection and purposeful professional development require a scaffolded learning experience and intentional practice. Students are strongly encouraged to embrace this spirit when engaging in this process, that is, persisting and putting effort into the IDP and semesterly reflections even if the benefits do not seem immediately obvious. To further enable this meaningful learning, the ownership of the process and artifacts is intentionally and necessarily located with the student to be pursued with initiative and agency.

Individual Development Plan (IDP)

When a student joins the program, the advisor/advisee team collaboratively completes an IDP that articulates a consensus around goals, commitments, and expectations along with an agreed upon process for meetings and collaboration. The IDP therefore acts as a kind of work contract that defines the relationship between the advisor and advisee. This relationship will change over the course of the PhD and so both parties are encouraged to view the IDP as a "living document" that is updated as needed.

Table 1 provides a structure for developing an Individual Development Plan (IDP) that reflects a consensus and shared commitment between student and advisor. The development of the IDP is led by the student who articulates their initial ideas, discusses all sections with their advisor, and compiles the final document to reflect the team's consensus. More specifically, a student completes a draft/outline of Section 1 before meeting with their advisor to discuss all sections of the IDP. Based on notes from the meeting the student compiles a first draft of all sections of the document for review by the Advisor and, if necessary, further discussion. The final document compiled by the student should be agreed upon and signed by both student and advisor.

Review and Reflection Process

The IDP is intended to be a living document that serves as a basis for planning and conducting individual and collaborative activities. It will be adjusted through a regular, annual review and reflection process. The reflection and review process will occur towards the end of each semester

Table 1: Worksheet and suggested sections for MoU

1. Student (drafted by student and revised after meeting with advisor):
Motivation What are your motivations for pursuing a graduate degree in Engineering Education and Transformative Practice? Try to give a sense of what drives your interest and what you are passionate about in this area. **Goals** What are your future goals that inform this choice? Try to capture your goals for what you want to achieve as part of the program, what your long-term career goals are, and what aspirations you have in terms of development of specific skills or your overall professional growth. Your goals could also include an area of interest or activity not directly connected to your dissertation but of personal interest and relevance to your future career. **Commitments** How do you understand your commitment to your overall graduate experience? Your description can touch on multiple areas such as research, coursework, instruction, participation in the intellectual community of EETI, broader campus involvement, etc. Try to capture the expectations you have of yourself in terms of time investment, initiative, commitment to excellence, and other aspects you think are important. **Expectations** What are your expectations for your graduate experience? Describe how you envisage support from your advisor, from the EETI community, and from the College/University. Try to capture which aspects and dimensions of support and mentorship are important for you and how specifically you imagine those being addressed. **Community** Community building is of central importance to a successful PhD process. However, community building and cultivation can be challenging, especially for somebody who is new to the field. Consider the following questions to sketch a plan for your work: Which communities (inside and outside of the College) are important for your PhD process? How do you plan to reach out to and connect with those communities? What do you expect from the EETI/College/research community in terms of support for your work and development? How do you foresee supporting and contributing to the EETI/College/research community?
2. Faculty (summarized by student after meeting with advisor):
Expectations What are your advisor's expectations? Consider a range of dimensions that include performance, time commitment, communication, professionalism, contributions outside of research assignment, participation in research groups and EETI community. **Commitments** What are your advisor's commitments to supporting your graduate expertise? Consider a broad range of potential modes of support such as mentoring, facilitating peer mentoring, addressing needs, providing time for broader engagement and initiatives.
3. Process of Collaboration (summarized by student after meeting with advisor):
Meetings What are agreements about regular meetings? Consider describing mode, frequency, time, responsibilities for agenda setting, record keeping, and task management. **Communication outside meetings** How does the team plan communication and collaboration outside of meetings? You could capture discussions about communication modes, frequency, etc. Also consider how collaborative development of research products is achieved. Discuss questions of credit and authorship. **Suggested components of professional development** The advisor/advisee team should discuss and plan for the following key components of a graduate student's professional development: peer review of manuscripts, proposal writing and review, instruction: Plan for appropriate experiences in instruction and associate mentoring, preparation for the profession / professoriate.

and require the student to submit a report that articulates the aspects outlined below for each reporting period. Table 2 provides a structure for the review and reflection process.

The intention of the reporting process is to be formative, supportive, and developmental. While this report does contain an element of progress reporting to support a student's timely progression towards their dissertation goals, the focus of the report and student-advisor interactions is to provide a space for purposeful reflection and improvement and cultivate habits of reflective professionalism. These skills and practices are arguably some of the most valuable outcomes of a student's PhD experience for their future career.

- *Table 2: Worksheet and suggested structure for semesterly review and reflection meetings*

Accomplishments Considering your activities during the past semester, what are the three things you are most excited about? The description of those highlights should include key activities towards the completion of your dissertation and could consider other accomplishments in research, instruction, community integration, or a student-defined area of interest.
Challenges and Surprises What key challenges did you encounter and what were surprises? In describing two to three critical incidents you could explore obstacles, emerging needs, or key insights.
Reflection ***Formative self-assessment*** Revisit the goals and milestones you defined in your IDP or the previous semester's report and evaluate your progress. The focus of the self-assessment should be formative and support your developing ability to scope and plan research projects, instructional initiatives, or other scholarly efforts. ***Effectiveness of own and collaborative processes*** Building on the above reflection on your progress, identify two or three key insights regarding your own process or your collaborative approach. You could consider elements like planning, communication, time management, and others.
Community What are your experiences and further plans for building your professional networks and becoming a part of communities at different levels? Which communities have proved to be important for your process? Who do you want to reach out to in the future?
Changes What are key changes for the coming semester? You could consider changes to your dissertation focus or approach, your coursework or to your modalities of working, communicating, or collaborating.
Goals Outline and briefly describe your goals and milestones for the coming semester. Consider your plans in research, instruction, and broader professional development and state clear, time-defined outcomes. Also, reflect on the ways in which your advisor, committee, or broader community could support your efforts and how you will seek out this support.

Expectations for Funded Graduate Research Assistants (GRA)

Often, the major professor of a graduate student is also their work supervisor for a funded, twelve-month graduate research assistantship (GRA). Although each supervisor will direct work expectations of the GRA in ways that make sense for the student, advisor, and project outcomes, there are a few key requirements for all GRAs in EETI:

- If a student is funded on a 12-month appointment, they may not pursue employment outside of the GRA, including internships.

- The work of the GRA will be assigned at the discretion of the supervisor. While we expect this work will benefit the student in their personal and professional development goals, the purpose of the GRA is to assist the supervisor on specific research-focused outcomes.
- All GRAs must occupy a physical presence in the graduate student workspace for a minimum of 80% of their allocated weekly hours.

If a GRA does not meet the expectations of their work assignments, the advisor should first try to communicate with the student to make clear that they are not meeting expectations. Likewise, the student should communicate any questions for clarification of work expectations. If a GRA continues to not meet expectations after meeting with their advisor, either the student or GRA may request mediation with the Director of Graduate Studies or Director (if the Director of Graduate Studies has a conflict of interest via advising the student). If the GRA continues to not meet expectations of their assignments, the advisor should evaluate the research course credit as unsatisfactory. Continued funding of the GRA will then be discussed among the advisor, GRA, and Director of Graduate Studies (or Director).

Exceptions to the above policies may only be approved by the Director of Graduate Studies and Director of EETI.

Guidelines for advisors to facilitate debrief

While the IDP and review and reflection process provide a productive scaffold for students' professional growth, the advisor plays a pivotal role in facilitating the process in ways that make it beneficial and successful. The following points reflect the shared values of EETI and provide guidance for engaging in the above-described activities, in which advisors commit to:

- Focus all interactions around the IDP and semesterly review and reflection on the productive professional development of the student rather than on punitive measures or compliance.
- Embrace a strength-perspective that considers individual assets students bring to the process based on a positive belief in a student's willingness to grow and succeed.
- Attend to and helping students intentionally engage with the process and meta-cognitive aspects of these activities.
- Assume our responsibility as mentors to clearly articulate academic and professional expectations to guide students' development. This responsibility includes thoughtfully and empathically communicating when students' performance or professionalism do not align with the shared commitment to excellence.

Formative project pitch to critical EETI friends

This community-integration non-evaluative element of the program serves as a first informal but important step to integrate new students into the local engineering education community. The informal presentation allows EETI faculty and EETP students to get to know a new student and learn about their research interests and future plans. In exchange, the student has an opportunity to get to know the local community and begin to identify potential resources, collaborators, and committee members. Hence, we recommend this first project and research presentation pitch happen before the end of the first semester.

A creative, informal presentation or group engagement is encouraged to engage the community around but is not limited to the following:

- Student's background
- Research interests and ideas

- PhD goals and potential focus areas

PhD students are encouraged to hold similar presentations to critical EETI friends on a regular basis. See Section 6 for additional opportunities for students to engage with the local engineering education community. Students are encouraged to actively reach out to this local community to support their professional development process.

5.2 Developing Program of Study

Link to EETP Information & Requirements

Candidates for the Ph.D. degree with an emphasis in *Engineering Formation and Transformative Practice* are expected to acquire the skills, knowledge, and orientations that enable them to make creative and original contributions to their discipline at the national or international level. The philosophy of the area of emphasis is grounded in a diversity of possible pathways that rely on students' agency and initiative in seeking out relevant coursework and interdisciplinary faculty expertise to support their chosen research project.

Requirements for the area of emphasis include a minimum of 73 credit hours in the student's program of study beyond the B.S. degree *or* a minimum of 42 credit hours in the student's program of study beyond the M.S. degree. Within this framework, EETI specifies the course requirements listed in Table 3.

Completion of the Ph.D. requirements for the area of emphasis must fulfill all requirements of the University of Georgia Graduate School. No grade below C will be accepted in the program of study. To be eligible for graduation, a student must maintain a 3.0 (B) average on the graduate transcript and a 3.0 (B) average in the program of study.

Table 3: EETI Course Requirements

	Minimum required credit hours for B.S. Entry*	Minimum required credit hours for M.S. Entry**
Engineering Education Core:	6	3
Methods:	6	3
Application:	6	3
Electives:	18	6
Graduate Seminar (ENED 8950)	1	1
Doctoral Research (9000 or 9010):	33	23
Doctoral Dissertation (9300):	3	3
*The program of study for a student who bypasses the master's degree must contain 4 semester hours of University of Georgia courses open only to graduate students in addition to 16 semester hours of 8000 and 9000 level courses. Doctoral research (9000), independent study courses, and dissertation writing (9300) may not be counted in these 20 hours. **The program of study for M.S. Entry students must contain 16 semester hours of 8000 and 9000 level courses. Doctoral research (9000), independent study courses, and dissertation writing (9300) may not be counted in these 16 hours.		

Additional Course Requirements

To graduate, students must have a strong foundation in educational research theory, methods, and their specific research topic. Therefore, in consultation with the graduate student, the advisory

team may require additional courses to ensure the student's necessary disciplinary preparation. For example, up to 12 additional credit hours may be required for M.S. Entry students without a background in educational research to ensure they are sufficiently prepared for their PhD program.

Serving as a Graduate Teaching Assistant (GTA)

If a graduate student in the EETP program wishes to serve as a graduate teaching assistant (GTA), they are required to take ENED 7010:

ENED 7010 - Preparing to Be an Effective Engineering Educator (Offered Fall Semester)

ENED 7010 is a teaching support course intended to help you discover who you are as a teacher, understand general principles that underlie effective teaching practices, and explore how teaching fits into your future goals and career path. The course will serve as a learning community to aid you in building a foundation of pedagogical knowledge and developing a repertoire of engineering teaching practices that can be adapted to a variety of teaching contexts you might encounter, both in academia and in industry.

Even if an EETP graduate student does not serve as a TA, they are encouraged to take ENED 7010 as an elective to aid in their professional development, especially if they intend to pursue a career with significant teaching responsibilities.

Plan of study and course offerings

Students are able to choose from a variety of courses, always in consultation with the major advisor. The following courses are offered in the Engineering Education Core section.

Engineering Education Core

ENED 8010* – Introduction to Engineering Education Research and Methodology

This course introduces students to the discipline of engineering education research from a historical, methodological, and content perspective. It is explicitly aimed at future engineering educators as well as future engineering education and engineering practice researchers. More specifically, the course explores the context of the grand societal challenges and the corresponding changes of the nature of engineering work as the trigger for the paradigmatic transformation of systems that support the professional formation of engineers. In the context of this broader discourse, the course explores the continuum from scholarly teaching, the scholarship of teaching and learning to educational and social research using current examples from the field.

*This course could count as an Engineering Education Core or Methods requirement. Additional ENED courses can, as appropriate, be counted as Methods, Application, or Elective requirements, e.g., ENED 8020, 8030, 8040, and 8050.

ENED 8020 – Current Issues as a Lens for the Integration of Engineering Education Research and Teaching Practice

This course offers a theoretically grounded understanding of current trends in engineering education research to serve the following two goals: first, to introduce graduate students to the

latest developments in the field and, second, to integrate this research perspective into the teaching practice of future engineering educators.

ENED 8030 – Educational Research and Evaluation Methods in Engineering

This course offers an introduction to educational research and evaluation methodologies in engineering education. Discussions of cutting-edge, discipline-based educational research provide a broad understanding of these methodologies, and the design, data collection, and analysis of a small research study encourages a deep understanding of these diverse methodological frameworks.

ENED 8040 – Theories of Learning and Human Development in Contemporary Engineering Education Research

This course introduces students to a range of theoretical perspectives that inform or underpin current curricular or teaching practices in engineering. This will serve future engineering education practitioners as a theoretical perspective to frame their own practice and future engineering education researchers as theoretical frameworks to inform systematic educational studies.

ENED 8050 – Systematic Literature Reviews and Meta-Analyses

This course offers an introduction to how to conduct systematic reviews and meta- analyses. Students will gain invaluable experience with scientific approaches to conducting literature review. As a final project, students will apply skills learned to conduct a systematic review or meta-analysis. Emphasis will be on collaborative and participatory learning.

Methods

Students may take courses in quantitative, qualitative, and/or mixed methods courses through the College of Education. Students should choose courses appropriate to their educational development in consultation with their faculty advisor. Recommended courses may include but are not limited to the courses displayed in Table 4. The courses should be chosen in consultation with the major advisor. In addition to methods courses within the ENED curriculum, the list below is a non-exhaustive list that may include some courses that are not offered. However, advisors and students may use this list to select courses or proposes others that fit these criteria.

Table 4: Select recommended methods courses

EDHI 8930	Qualitative Research in Higher Education
QUAL 8400	Qualitative Research Traditions
EDHI 8910	Quantitative Methods in Higher Education I
QUAL(ERSH) 8575	Mixed Methods Approaches to Research
EDIT 8290	Design-Based Research Methods
EDHI 8200	Institutional Research
ANTH(GEOG)(SOCI) 8430	Community-Engaged Research (Praxis)
ETAP(QUAL) 8040	Video Ethnography of Education
SOWK(MNPO) 7106	Evaluation of Community and Institutional Practices
ERSH 6200	Methods of Research in Education
ERSH 6300	Applied Statistical Methods in Education
ERSH 9210	Quantitative Design in Education

ERSH 8610	Theories of Educational Measurement
ERSH 7250	Educational Program and Project Evaluation
EDHI 8930	Qualitative Research in Higher Education

Application and Electives

Course selection in the Application and Electives area draws on the full breadth of graduate course offerings in technical and non-technical fields that provide specific content, theory, or methods to support and ground the students' chosen research trajectory.

Students are expected to choose a minimum of 6 (3 for M.S. Entry.) credit hours of coursework to provide a deep understanding of the application context of their research project. Table 5 provides a list of courses in some example areas that a student's dissertation may focus on. This list is neither intended to be comprehensive nor constitute a recommendation – the choice of specific courses is determined through the active suggestion of the student and in consultation with the major professor. In addition to methods courses within the ENED curriculum, the list below is a non-exhaustive list that may include some courses that are not offered. However, advisors and students may use this list to select courses or proposes others that fit these criteria.

Graduate Seminar

The graduate seminar is designed for students to learn from pioneers of the field and learn from experts to stay current with up-and-coming engineering education research. Students are required to enroll in 1 credit hour of seminar on a recurring basis until they have passed their proposal. All students are required to participate in weekly seminars throughout their doctoral program regardless if they are enrolled for credit.

Table 5: Sample application & elective courses. Some courses may no longer be offered from this example

Organizations	
ALDR 8030	Diffusion of Innovations
ALDR 7350	Team and Organizational Development
BUSN 7500	Business Ethics
ECHD 9080	Advanced Theories and Procedures of Group Work
ECON 8210	Industrial Economics I
MNML 7947	Social Entrepreneurship
Environment/Agriculture	
PHIL(EETH) 4220/6220	Environmental Ethics
EETH(JURI) 5870/7870	Environmental Dispute Resolution
ALDR 8500	Change Theories in Environmental Conservation
AGCM 8100	Culture-Centered Communication and Engagement
ECOL 8730	Environmental Policy
Inclusive Excellence	
WMST(AFAM) 4060/6060	Black Feminism
AFAM(PSYC) 4500/6500	Psychology of Prejudice
SOCI(AFAM) 6370	Sociology of Race and Ethnicity
EFND(ANTH) 7150	Anthropology of Education
EDIT 6600	Diversity, Technology, and Learning
ECHD 9930	Equity, Diversity, and Inclusion in Student Affairs
ECHD 9320	Teaching and Diversity

Educational Contexts	
ECHD 9420	Advanced Theories of College Student Development
ECHD 9410	Organizational Development and Consultation in Higher Edu.
EBUS 5070/7070	Contemporary Entrepreneurship & Management Practices for Educators
EDAP 8070	Ethics in Educational Leadership
ECHD 8290	Social Justice & Liberation Frameworks in School & Community Settings
EDHI 9040	Using Technology in the College Classroom
EDIT 8400	Games and Learning
K-12 Engineering Education	
EDAP 8040	Social Psychology of Schools
ECHD 8310	Social Justice Assessment and Program Evaluation in P-16 Settings
EDEC 8030	Research Perspectives in Early Childhood Education
Engineering and Society	
COMM 8350	The Rhetoric of Science
PHIL(EETH) 4250/6250	Philosophy of Technology
JURI 5580/7580	Law, Science, and Technology
Instructional Design & Technology	
EDIT 6150	Introduction to Digital Learning
EDIT 6170	Instructional Design
EDIT 7500	Project, Problem, and Place-Based Learning
EDIT 8400	Games and Learning
EDIT 7200	Professional Learning through Technology

Exceptions to this requirement may only be granted on a semesterly basis by the Director of Graduate Studies.

Doctoral Research and Dissertation

Doctoral research credits are designed to indicate an active progression through the dissertation process with the major professor.

5.3 Building Advisory Committee

The selection of the Advisory Committee follows the process and criteria outlined in the CENGR graduate handbook. In close coordination with the advisor, the student is expected to take an active role in identifying, suggesting, and communicating with potential committee members. EETI faculty must occupy at least half of the committee member positions. Committees may include one EETI affiliate[2] faculty member, which can count toward this total of EETI faculty. In addition, the majority of the committee must be composed of faculty from the College of Engineering.

The role and function of the advisory committee can be understood in analogy to an advisory board of a research project and students can use this opportunity to develop the professional skill of purposefully assembling and productively using an advisory board. In this sense, advisory committee members serve in consulting, mentoring, and evaluative roles. In turn, this means that the advisory committee should be assembled to provide the relevant range of expertise to support the student's dissertation project. In their evaluative function, advisory committee members play a key role in the comprehensive exam, the proposal defense, and the dissertation defense. The

committee members' input in these assessment milestones should be formative and focus on supporting, guiding, and directing the student's dissertation journey and professional growth trajectory while maintaining shared expectations of excellence and professionalism.

The student is expected to take an active role in engaging committee members in productive ways according to their role and expertise relative to the dissertation project. Modes of support could take the form of an ongoing collaborative relationship or periodic, target consultations managed by the student with support from their advisor.

5.4 Passing Comprehensive Exam

The comprehensive exam is an assessment that students must complete by the end of the second year of their PhD program or after completing all required preparatory coursework. The comprehensive exam comprises a written and oral component and serves to evaluate the student's preparedness for Ph.D. candidacy. After passing the exam, the student may apply for Ph.D. candidacy with the UGA Graduate School.

The focus of the exam is formative and developmental to support the student's progress in defining their dissertation project while demonstrating a broad, yet purposeful, grounding in discourses relevant to their research interests. The exam assesses the student's competency in knowledge of fundamental theoretical perspectives or frameworks and research methods that are essential to completing their dissertation research. The examination will also assess their understanding of the practical relevance of such theoretical perspectives to engineering education practice. The examination helps the advisory committee to evaluate the student's: (i.) ability to design and conduct doctoral research; (ii.) development as an engineering education researcher, and; (iii.) ability to communicate their research in a way that is accessible to a broader audience.

Because the exam will assess student's mastery of theory, research methodology, and the advancement of theory-to-practice in engineering education, determining when is appropriate to take the exam should be deliberately decided between PhD students and their advisor. Students are more likely to be better prepared, and monitor their own progress toward PhD candidacy, if the timing of the exam is considered while planning a tentative program of study during student advisement at the start of their doctoral program.

Written Component

The written comprehensive exam will be a take-home examination that comprises the student's responses to a set of four to five questions developed by the members of the advisory committee and coordinated by the advisor. The questions are intended to lay the groundwork for the various dimensions of the dissertation and should cover the following aspects:

- Review of relevant bodies of literature with a view to identifying research needs, opportunities, or gaps. (*Goal: Ensure that the student's work is sufficiently based on prior work and grounded in the scholarly discourse*)
- Discussion of relevant theoretical perspectives that could serve to frame the dissertation research and evaluation of their applicability. *(Goal: Ensure that the student's work is sufficiently framed and guided by existing theory)*
- Examination of appropriate methodological approaches and their underlying theoretical perspectives with a view to developing a vision for the research design of the dissertation study. *(Goal: Ensure that the student's work sufficiently connects theory and methodology for the envisioned research design)*

- Consideration of areas of practice or scholarship that the dissertation project could contribute to and a discussion of relevance, impact, or application for particular audiences including potential limitations of the work. *(Goal: Ensure that the student is able to sufficiently describe the scholarly and practical relevance and limitations of the own work with respect to the addressed audience)*
- Exploration of critical perspectives that broaden the student's perspective on elements of their dissertation project or journey. The focus of this question could range from explorations of the student's subjectivity or positionality relative to the research interest, application of critical theory perspectives around race, gender, and class to their areas of inquiry, or critical examination of the interplay of engineering, technology, and society relevant to the dissertation's focus. *(Goal: Ensure that the student is able to critically reflect on their own work with regard to the taken perspective, possibly existing blind spots, or expected outcomes)*

The written examination is expected to be an independent product. As such, students taking the comprehensive exam may not consult with other individuals about the questions on the examination. However, a student may seek clarifications about questions or the format of responses to the examination questions. The response to each question should in scope, quality, and literature support be equivalent to a short conference article in the candidate's field of study. The major professor shall compile students' responses and communicate them to committee members at completions of the written exam.

Committee members may provide written feedback ahead of the oral defense, or defer such feedback until the oral defense. The details of sequence, timing, and submission for the take-home examination are collaboratively determined by the advisor and student to account for the student's needs and circumstances.

Preparing for the comprehensive exam

The graduate school requires that doctoral students enroll in three-credit hours of dissertation research credits in the semester in which they take their comprehensive examination. Students who intend to take the exam should indicate their intention with their advisory committee through the major professor ahead, or at the beginning, of the semester in which the examination will be conducted. The student will be required to submit a 1-2 page document describing a specific area of research interest that they have been reading around. The advisory committee may also require a list of relevant literature in the area of the student dissertation research interest. The reading list often helps the exam committee to write questions that are tailored to better support the students' dissertation research goal.

Doctoral students who contemplate writing the exam are strongly advised to familiarize themselves about documentations and graduate school deadlines when scheduling the comprehensive examination within any given semester. Failing to do so could mean that the examination may not occur as they had intended.

Committee Review

The committee will review student's written responses within four weeks. At the major professor's discretion, the committee could meet (without the student) to discuss how members would evaluate and score student's responses. Evaluation and feedback could also be deferred to the conclusion of the oral examination. The major professor may compile and provide feedback from the committee to the student before or after the oral exam is completed. Student's responses will

be scored as: 1) Exceeds expectations, 2) Meets expectations, or 3) Does not meet expectations. The committee may communicate their feedback to the student at the end of the oral examination.

Oral Examination

The student gives a brief, high-level overview of the written portion of the exam with a view to providing a sense of synthesis across the individual questions. The presentation should also include an explicit reflection on the student's own process and experience along with insights or decisions prompted by working on the questions.

The bulk of the oral examination is dedicated to questions by and discussion with the committee members. The questions follow up on the topics of the written exam, in particular with a view to translating the exploration and visioning in the comprehensive exam into a clear, concrete plan for their dissertation project as represented in the proposal.

The Graduate School has strict deadlines on when exams may be completed across the university. In light of this, students who intend to take the comprehensive examination are strongly advised to consult with members of their advisory committee to find suitable time for the oral examination in advance of the written examination is being scheduled. The examinee shall submit all necessary scheduling forms to the Graduate School no later than 10 working days to the oral examination date.

Retaking the examination: Depending on the committee's evaluation of both the written and oral examinations, a student may be required to retake one or all parts of the examination. The committee will compile new question(s). The new question(s) may be tailored to address specific deficiencies that the committee identified in the previous examination. Students who need to retake the examination shall be responsible for all examination rescheduling in line with graduate school requirements.

Post-comprehensive examination: As per the College guidelines the committee discusses the written and oral components of the comprehensive exam and determines the student's readiness for PhD candidacy. Doctoral students who successfully complete the comprehensive examination will be admitted to candidacy. Students should ensure to complete all necessary graduate school forms that documents their milestone achievement and admission to PhD candidacy. Once the comprehensive examination requirement is satisfied, PhD candidates should consult with their advisors about the next steps in completing their PhD dissertation in a timely manner.

5.5 Delivering Proposal Defense

According to CENGR guidelines "the student completes a written proposal of the research plan for her/his dissertation and orally presents and defends this proposal to his/her Advisory Committee, receiving input to improve the plan. The student may be requested to explore specific topics in writing for the committee". "The proposal should occur no less than two weeks after and no more than one year after the comprehensive exam."

The Proposal represents a distinct step in the development of a doctoral candidate's dissertation project beyond the comprehensive examination. More specifically, where the comprehensive exam comprised a broad exploration and evaluation of relevant scholarship to develop a vision for the dissertation, the proposal develops this vision into a specific, appropriately scoped, well-supported, and time-defined project plan.

Leveraging the professional development opportunity inherent to this assessment milestone, the Proposal takes the form of an application for extramural fundings to an agency or organization relevant to the student's area of scholarship. The proposal should be written as a 15-page

National Science Foundation (NSF) proposal and be accompanied by a one-page summary. The project description (15 pages) should comprise all relevant sections of a research plan including the dissemination of project outcomes. Further, the proposal should speak to the intellectual merit and broader impacts of the proposed dissertation work.

The advisor will distribute the proposal to the committee and schedule an oral defense during which the student presents their research proposal. The presentation should give a coherent sense of the planned research and make a compelling case for its timeliness, novelty, and relevance as well as the soundness of the overall plan.

Based on the presentation, the committee members will be invited to pose questions to explore and further refine the research plan to ensure its feasibility. The committee will consider the proposal and the student's responses to determine their readiness to embark on the dissertation project.

5.6 Delivering Dissertation and Final Defense

The dissertation is the culminating manuscript of the candidate's doctoral research. It should be written in a manner that details the candidate's work and is prepared for publication for the broader engineering education community (publication is not a requirement for degree completion). The dissertation must be submitted to the student's advisory committee at least four weeks prior to the Final Defense. The dissertation must be approved by all members of the student's advisory committee, usually upon successful completion of the Final Defense. If a committee member does not approve the dissertation, upon the faculty member's request, a written dissenting opinion can be bound with the final document. A successful candidate is allowed a maximum of one negative vote. Dissertations must be filed and approved electronically with the Graduate School through the GradStatus and ETD systems. The student, advisor, committee members, and the College of Engineering Graduate Program Coordinator are notified once required Graduate School processes are complete and the document is available online.

All graduate students pursuing a Ph.D. are required to pass an examination with an oral defense administered by the advisory committee. To schedule a Final Defense, the student must submit their dissertation manuscript to their committee four weeks prior to the exam and notify the CENGR Graduate Program Coordinator three weeks prior to the exam. EETI's policy requires that faculty are given two weeks to read documents prior to signing the scheduling request. For scheduling of the final examination, the dissertation must be ready for defense (i.e., any revisions to the written document should be able to be completed within two weeks) as judged by committee members having read the document and signed a departmental examination scheduling request. The student must be able to complete all other degree requirements within the semester when the examination is held: all coursework on the Plan of Study will need to be completed with grades of C or higher and both the Plan of Study GPA and the overall GPA must be a 3.0 or higher by the end of the semester. Final Defenses are open to the public and must be advertised as soon as the exam is scheduled with the Graduate School. Students are required to submit their dissertation abstract (150-300 words) and their professional biography (50-100 words) to the Director of Graduate Studies when they send the request to the Graduate School. The Director of Graduate Studies then sends out the announcement no later than two weeks prior to the final defense date. To pass the Final Defense, a degree candidate must have a favorable vote from a majority of the examining committee, with a maximum of one negative vote. The result of the Final Defense must be reported to the Graduate School through the Electronic Thesis and Dissertation (ETD) system.

6 Expectations to Facilitate Community Integration

Although completing a PhD involves significant individual effort, the most successful graduate students conduct their studies as part of a broader academic community. This community starts with the important relationship between the student and their advisor and extends all the way to building relationships with international experts in their area of interest. We illustrate these relationships and different levels of community in Figure 2. This section outlines a range of activities that can support engineering education PhD students as they progress through their studies and interact with these communities.

6.1 The core team: The EETP graduate student, their major professor, and their advisory committee

Arguably the most important relationship that supports successful doctoral research is the relationship between the student and their major professor. This relationship is discussed in detail in Sections 4 and 5 above.

6.2 The local Engineering Education community

Level 2a: The EETP graduate student and the EETI faculty community

The EETI faculty community has a diverse range of skills and experiences that students are encouraged to take advantage of. In order to develop relationships with the EETI faculty community, students are required to:

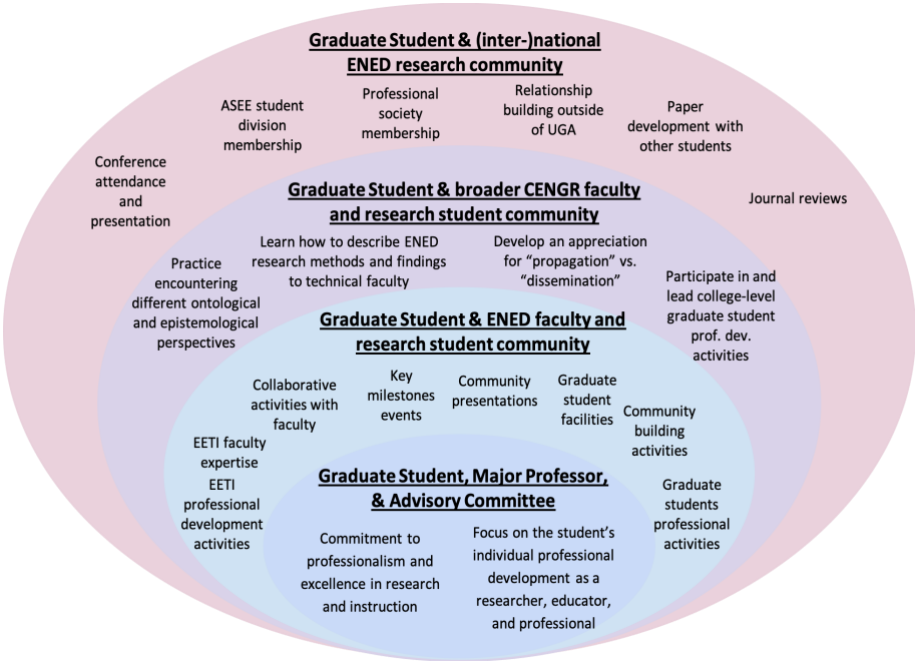

Figure 2: Four levels of community that an EETP graduate student is encouraged to engage with and suggested activities

- Participate in/take advantage of EETI professional development activities, such as the monthly forums, the EETIncubator, and workshops.
- Attend key milestone events of other EETP students and College members, such as job talks and third year reviews.
- Take advantage of EETI faculty expertise and experience by asking for specific feedback on research ideas, plans, and products.
- Reach out to the core/wider EETI faculty community for collaborative activities.
- Leverage the diverse expertise of the EETI faculty community by soliciting feedback as part of the Formative Project Presentation/Pitch to Critical EETI and the Local EETI Community Friends.

Level 2b: The EETP graduate student and their peers

For many graduate students, near-peer learning is the most important part of their professional development. Students are encouraged to:

- Contribute to the EETP graduate student community by sharing information (e.g., research processes, events, and contacts), supporting each other, collaboratively developing research ideas, practicing presentations, and providing constructive feedback.
- Be physically present in EETI's graduate student facilities to support community building. One of the best ways to facilitate near-peer learning is for students to be co-located. That way, when questions arise students can easily reach out to one another for advice and support. Graduate students are encouraged to take advantage of EETI's shared workspaces.
- Organize graduate student professional development events on relevant academic topics (e.g., workshops on research proposal development, data gathering instruments, writing research papers, etc.).

6.3 The College of Engineering (CENGR) community

Level 3a: The EETP graduate student and the broader CENGR faculty community

The Engineering Education Transformations Institute (EETI) is purposefully designed to sit across the four interdisciplinary Schools in the College of Engineering at UGA. This administrative structure provides EETP graduate students with direct access to EETI and technical faculty members. For graduate students who are interested in pursuing academic careers, this model of community integration provides opportunities to develop relationships with faculty members outside of EETI. Graduate students will benefit from developing these relationships in multiple ways, including, but not limited to:

- Exposure to and practice engaging with different ontological and epistemological perspectives.
- Learning how to describe engineering education research methods and findings to a broader audience such as lecturers, technical faculty, etc.
- Opportunities to develop an appreciation of the importance of "propagating" vs. "disseminating" findings and insights from educational research.

Level 3b: The EETP graduate student and other CENGR research students

EETP graduate students are encouraged to recognize that there are commonalities across all PhD experiences, such as the need to maintain a positive and productive relationship with one's advisor, the need to develop a research plan, build a reputation, write and present conference papers, publish in top-tier journals etc. As such, EETP graduate students are encouraged to:

- Take advantage of graduate student professional development opportunities offered at the college level.
- Participate in and take on leadership roles in College-level graduate student activities.

6.4 The broader Engineering Education (ENED) community

It is essential to the EETP graduate student professional development process to build connections and professional networks beyond the school's context with the broader community. In order to develop relationships with the national and international ENED community, students are encouraged to:

- Attend and present at regional, national, and international conferences that are relevant to the dissertation topic, e.g., ASEE Southeastern Section Conference, ASEE Annual Conference and Exposition, Frontiers in Education Conference, European Society for Engineering Education Annual Conference (SEFI).
- Become member of and participate in the ASEE Student Division (http://students.asee.org/) as well as participation in other relevant ASEE divisions as part of the ASEE national conference.
- Review for journals that are relevant to their own field and topic, e.g., *Journal of Engineering Education*, *Studies in Engineering Education*, *European Journal of Engineering Education*, and *Australasian Journal of Engineering Education*
- Identify at least two faculty members outside of UGA who are experts in the student's field of interest and start to develop relationships with these faculty members.
- Author at least one conference paper with students from other engineering education graduate programs.

Appendix A: Admission requirements for non-engineering applicants

Students with a B.S. in non-engineering, natural sciences, or technical disciplines are expected to work with their advisor to complete the coursework that provides the necessary engineering grounding to ideally support their further plan of study and research. The following specifies four areas of engineering grounding and a suggested number of courses that provide guidance to the student and advisor in selecting the additions to the program of study. The suggested lists of courses are not exhaustive and may contain some courses that are not offered. However, they are intended to provide guidance for the decision that is made collaboratively between the student and their major advisor.

As an example of a plan for such groundings, students may select at least 12 credit hours in one or several of these areas. To account for the necessary breadth and depth of the engineering grounding, a reasonable spread of courses across the levels of undergraduate study is expected. PhD advisors and graduate committees are expected to maintain this balance in accordance with the needs and trajectory of the individual student.

(a) Engineering Design

The engineering grounding area of engineering design focuses on engineering knowledge and practices related to the conceptualization and design of technical artifacts or systems in a range of application contexts. Courses in this engineering grounding area may, for example, align with dissertation research that focuses on aspects of design education in formal or informal settings or technical developments in engineering practice contexts.

ENGR 1920	Intro to Engineering (1hr)
AENG 2920	Design Methodology (2 hrs)
BCHE 2910	Intro Biochemical Engr. Design (3 hrs)
ENVE 3410	Intro Natural Resources Engr. (3 hrs)
CVLE 3610	Structural Design (3 hrs)
CSEE 2220	Fundamentals of Logic Design (3 hrs)
CSEE 2920	CSEE Design Methodology (2 hrs)
CSEE 4270	Design of Digital Systems (3 hrs)
CSEE 4280	Advanced Digital Design (4 hrs)
CSEE 4230	Embedded Systems Design I (3 hrs)
CSEE 4235	Embedded Systems Design II (3 hrs)
ENVE 2920	ENVE Design Methodology (3 hrs)
MCHE 1940	ME Design Studio/Prof. Practice (3 hrs)
MCHE 3300	Machine Design I (3 hrs)
MCHE 3920	Manufacturing & Design Studio (3 hrs)
ENGR 4910	Engineering Design Project I (2 hrs)
ENGR 4911	Engineering Design Project II (2 hrs)

(b) Engineering Professionalism

The engineering grounding area of engineering professionalism focuses on engineering as a professional practice that reaches across a broad range of disciplines, domains, or industries, thus recognizing the status of engineering as a profession, and of engineering education as a professional degree. Courses in this engineering grounding area may, for example, align with dissertation research that focuses on aspects of engineering students' professional formation. This broad area includes, for example, questions around how individuals come to and progress in the profession, the development of professional skills and self-perceptions, and engineering ways of knowing and doing in professional practice.

ENGR 1920	Intro to Engineering (1hr)
CSEE 2200	Intro to Computer Systems Engr. I (2 hrs)
AENG 2100	Principles of Systems Engineering (3 hrs)
ELEE 1030	Intro to Electrical Engineering (3 hrs)
ENGR 2110	Engineering Decision Making (3 hrs)
CVLE 3730	Civil Engineering Project Mgmt (2 hrs)
CSEE 2210	Intro to Computer Systems Engr. II (2 hrs)
ENVE 2610	Intro ENVE & Sustainability (3 hrs)
ENVE 3520	Engr. Economics & Management (3 hrs)
MCHE 1940	ME Design Studio/Prof. Practice (3 hrs)
MCHE 2990	Engineering Systems in Society (3 hrs)
MCHE 4000	ME Professional Practice (2 hrs)

(c) Engineering Science

The engineering grounding area of engineering science focuses on the application of natural and engineering sciences as one of the key foundations of engineering work. Courses in this engineering grounding area may, for example, prepare students for dissertation research that examines student learning and development in the engineering sciences, the role of preparation in mathematics and the sciences in engineering learning, and the connection between engineering science learning and other aspects of engineering students' educational experience.

ENGR 2120	Statics (3 hrs)
ENGR 2130	Dynamics (3 hrs)
ENGR 3140	Thermodynamics I (3 hrs)
ENGR 3150	Heat Transfer (3 hrs)
ENGR 3160	Fluid Mechanics (3 hrs)
BCHE 3520	Mass Transport/Rate Phenomena (3 hrs)
CVLE 3420	Introduction to Soil Mechanics (3 hrs)
CSCI 2611	Discrete Math for Engineers (3 hrs)

ELEE 4020	Electromagnetics (3 hrs)
ELEE 4210	Linear Systems (3 hrs)
ENVE 3210	Energy Analysis I (3 hrs)
ENVE 3220	Energy Analysis II (3 hrs)

(d) Engineering Technology

The engineering grounding area of engineering technology focuses on the technological knowledge, processes, artifacts that undergird engineering as a field and profession. Courses in this engineering grounding area may, for example, provide the foundation for dissertation research that explores how engineering students' and practitioners use or engage in the creation of technology; what role technical artifacts play in engineering learning, collaboration, and communication; or how technological artifacts are shaped by the interplay of engineering and social systems.

ENGR 1120	Engineering Graphics (2 hrs)
ENGR 1140	Computational Engr. Methods (2 hrs)
ENGR 2170	Electrical Circuits (3 hrs)
AENG 2180	Intro Modeling of Dynamic Systems (3 hrs)
AENG 4140	Systems Modeling (3 hrs)
BCHE 3420	Kinetics & Reactor Design (3 hrs)
BIOE 4740	Biomaterials (3 hrs)
CVLE 2210	Principles Surveying & Transportation (2 hrs)
CVLE 2710	Numerical Methods for Engineers (2 hrs)
CVLE 3310	Civil Engineering Materials (3 hrs)
CSCI 1301	Intro to Computing/Programming (4 hrs)
CSCI 1302	Software Development (4 hrs)
CSCI 1730	Systems Programming (4 hrs)
CSCI 2720	Data Structures (4 hrs)
ELEE 2040	Programming for Electrical Engrs (3 hrs)
ELEE 3270	Electronics I (3 hrs)
ELEE 4230	Sensors & Transducers (3 hrs)
ELEE 3270	Electronics I (3 hrs)
ELEE 4270	Electronics II (3 hrs)
CSEE 4210	Digital Signal Processing (3 hrs)
ELEE 4220	Feedback Control Systems (3 hrs)
ELEE 4240	Microcontrollers (3 hrs)
ELEE 4710	Fundamentals of Power Engineering (3 hrs)

ELEE 4750	Power System Analysis (3 hrs)
ELEE 4590	Principles of Communication Systems (3 hrs)
ENVE 3320&L	ENVE – Urban Systems (4 hrs)
MCHE 3300	Machine Design I (3 hrs)
MCHE 3310	Engineering Materials (3 hrs)
MCHE 3920	Manufacturing & Design Studio (3 hrs)

Prerequisite requirements for technical grounding courses

In consideration of the individual students' preparation and appropriate plans for independent study, prerequisites for these courses may be waived with approval by and upon request of the student's major professor.