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University Council

April 20, 2018

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Dear Colleagues:

The attached proposal from the College of Engineering for a new Area of Emphasis in Engineering Education and Transformative Practice under the major in Engineering (Ph.D.) will be an agenda item for the April 27, 2018, Full University Curriculum Committee meeting.

Sincerely,

Alison Alexander

Alison F. Alexander, Chair
University Curriculum Committee

cc: Provost Pamela S. Whitten
Dr. Rahul Shrivastav

Proposal for an Area of Emphasis

College: College of Engineering

Unit: College of Engineering

Degree/Major: Engineering (Ph.D.)

Emphasis Title: Engineering Education and Transformative Practice

Proposed Start Date: Fall 2018

Overview

The Area of Emphasis in Engineering Formation and Transformative Practice prepares graduates for broad practice and academic applications at the intersection of human and technical systems. Through an innovative fusion of methods of social inquiry, knowledge of human development, and tools for positive change embedded in a context of deep technical competence, graduates are enabled to provide transformative leadership in a variety of educational, technical, and organizational settings. Upon graduation, students will be able to apply their unique skill set to a diverse range of contexts, including formal and informal education environments, engineering practice, learning organizations, social entrepreneurship, customer discovery, leadership, and policy.

Engineering Formation and Transformative Practice builds on disciplinary strengths in engineering education research, the interdisciplinary breadth of a broad graduate course offering in a major liberal arts university, and the technical context of being embedded in the innovative education and research mission of our College of Engineering. This unique setting provides students with access to a broad range of content, variety of faculty expertise, and diverse application settings as the foundation for shaping their individual programs of study and research trajectories.

Requirements

Candidates for the Engineering Ph.D. with an Area of Emphasis in Engineering Formation and Transformative Practice are expected to acquire the skills, knowledge, and orientation 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 as follows:

Direct Ph.D. with B.S. degree

Requirement	Credit Hours
Focus area courses (6 per area)*	18
Elective Course work*	18
Graduate seminar	1
Doctoral research (9000 or 9010)	33
Doctoral dissertation (9300)	3

*Across selected courses a minimum of 16 hours of 8000 or 9000 level courses and an additional 4 hours of courses open to only graduate students is required.

A thesis master's degree from an accredited university may be accepted for up to 30 credit hours, in which case a minimum of 42 credit hours of approved course work, research and dissertation beyond the M.S. degree is required as follows:

Requirement	Credit Hours
Focus area courses (3 per area)*	9
Elective Course work*	6
Graduate seminar	1
Doctoral research (9000 or 9010)	23
Doctoral dissertation (9300)	3

*Across selected courses a minimum of 15 hours of 8000- or 9000-level courses is required.

Completion of the Ph.D. requirements for the area of emphasis fulfill all requirements of the University of Georgia Graduate School. No grade below C (2.0) will be accepted in the program of study. To be eligible for graduation, a student must maintain a B (3.0) average on the graduate transcript and a B (3.0) average in the program of study.

Area of Emphasis Description

The area of emphasis comprises two broad pathways that frame the flexible and context-appropriate development of the individual plan of study and research.

(i) Engineering Formation focuses on the complex processes that underpin the learning and professional socialization of engineers across the k through gray spectrum. Areas of interest include, but are not limited to, questions of teaching and learning in university, k-gray, and informal settings; development of technical competence and broad professional attributes such as creativity, empathy, and ethical reasoning; the innovative use of technology in education; and issues of underrepresentation and inclusiveness in engineering.

(ii) Engineering Epistemologies focuses on investigating and understanding engineering knowing and doing in contemporary engineering practice settings. Areas of investigation include, but are not limited to, engineering work at the intersection of organizational practices, disciplinary domains, and cutting-edge technological developments; professional development in interdisciplinary and inter-professional spaces; and collaboration, innovation, and cross-domain integration that characterize engineering work in the context of 21st century grand challenges.

Coursework

The recommended course offering is organized in three focus areas. Individual programs of study will be developed collaboratively between the student and their major professor in accordance with the above requirements. The student and advisor will seek permission for the specific courses chosen on an individual basis.

(a) Engineering Formation Core
The core engineering formation courses provide an understanding of the landscape of this globally connected discipline. Individual course offerings focus on theories of learning and human development in engineering, contemporary issues in engineering formation, and research and evaluation methods in

engineering education and practice contexts.

Students are expected to choose a minimum of 3 (6 for direct Ph.D.) credit hours from the following engineering formation core courses:

Current course offering:
ENED 8010, Introduction to Engineering Education Research and Methodology (3 hours)
ENED 8020, Current Issues as a Lens for the Integration of Engineering Education Research and Teaching Practice (3 hours)
ENED 8030, Educational Research and Evaluation Methods in Engineering (3 hours)
ENED 8040, Theories of Learning and Human Development in Contemporary Engineering Education Research (3 hours)

Courses planned / under development:
ENED XXXX, Foundations of Science and Technology Studies (3 hours)
ENED XXXX, Independent Study in Engineering Formation and Transformative Practice (3 hours)

(b) Social and Educational Inquiry Methods
The research methods courses draw on the broad offering of courses across the University of Georgia, including the College of Education. In line with the student's research project, these courses can comprise offerings in the qualitative, quantitative, or mixed methods areas.

Students are expected to choose a minimum of 3 (6 for direct Ph.D.) credit hours of advanced coursework in educational or social research methods. The following provides a list of sample courses. This list is neither intended to be comprehensive nor to constitute a recommendation–the choice of specific courses is determined through the active suggestion of the student and in consultation with the major professor.

ANTH(GEOG)(SOCI) 8430, Community-Engaged Research (Praxis) (3 hours)
EDHI 8200, Institutional Research (3 hours)
EDHI 8910, Quantitative Methods in Higher Education I (3 hours)
EDHI 8930, Qualitative Research in Higher Education (3 hours)
EDIT 8290, Design-Based Research Methods (3 hours)
ERSH 6200, Methods of Research in Education (3 hours)
ERSH 6300, Applied Statistical Methods in Education (3 hours)
ERSH 7250, Educational Program and Project Evaluation (3 hours)
ERSH 8610, Theories of Educational Measurement (3 hours)
ERSH 9210, Quantitative Design in Education (3 hours)
ETAP(QUAL) 8040, Video Ethnography of Education (3 hours)
QUAL 8400, Qualitative Research Traditions (3 hours)
QUAL 8575, Mixed Methods Approaches to Research (3 hours)
SOWK(MNPO) 7106, Evaluation of Community and Institutional Practices (3 hours)

(c) Application and Context
Course selection in the Application and Context 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 trajectories.

Students are expected to choose a minimum of 3 (6 for direct Ph.D.) credit hours of coursework to provide a deep understanding of the application context of their research project. The following provides a list of courses in some sample areas that a student's dissertation may focus on. This list is neither intended to be comprehensive nor to constitute a recommendation–the choice of specific courses is determined through the active suggestion of the student and in consultation with the major professor.

Organizations
ALDR 7350, Team and Organizational Development (3 hours)
ALDR 8030E, Diffusion of Innovations (3 hours)
BUSN 7500, Business Ethics (1.5 – 3 hours)
ECHD 9080, Advanced Theories and Procedures of Group Work (3 hours)
ECON 8210, Industrial Economics I (3 hours)
MNML 7947, Social Entrepreneurship (3 hours)

Environment/ Agriculture
AGCM 8100, Culture-Centered Communication and Engagement (3 hours)
ALDR 8500E, Change Theories in Environmental Conservation (3 hours)
ECOL 8730, Environmental Policy (3 hours)
EETH(JURI) 5870/7870, Environmental Dispute Resolution (2 hours)
PHIL(EETH) 4220/6220, Environmental Ethics (3 hours)

Diversity
AFAM(PSYC) 4500/6500, Psychology of Prejudice (3 hours)
ECHD 9320, Teaching and Diversity (3 hours)
ECHD 9930, Equity, Diversity, and Inclusion in Student Affairs (3 hours)
EFND(ANTH) 7150, Anthropology of Education (3 hours)
SOCI(AFAM) 6370, Sociology of Race and Ethnicity (3 hours)
WMST(AFAM) 4060/6060, Black Feminism (3 hours)

Educational Contexts
EBUS 5070/7070, Contemporary Entrepreneurship and Management Practices for Educators (3 hours)
ECHD 8290, Social Justice and Liberation Frameworks in School and Community Settings (3 hours)
ECHD 9410, Organizational Development and Consultation in Higher Education (3 hours)
ECHD 9420, Advanced Theories of College Student Development (3 hours)
EDAP 8070, Ethics in Educational Leadership (3 hours)
EDHI 9040, Using Technology in the College Classroom (3 hours)
EDIT 8400, Games and Learning (3 hours)

K-12 Engineering Education
ECHD 8310, Social Justice Assessment and Program Evaluation in P-16 Settings (3 hours)
EDAP 8040, Social Psychology of Schools (3 hours)
EDEC 8030, Research Perspectives in Early Childhood Education (3 hours)

Engineering and Society
COMM 8350, The Rhetoric of Science (3 hours)
JURI 5580/7580, Law, Science, and Technology (3 hours)
PHIL(EETH) 4250/6250, Philosophy of Technology (3 hours)

Admission Requirements

Students holding a B.S. degree or M.S. in engineering from an ABET-accredited program or a B.S. or M.S. in a related field from an accredited institution are invited to apply for admission into the doctoral program with the emphasis in Engineering Formation and Transformative Practice.
Students with a B.S. in non-engineering, natural sciences, or technical disciplines are expected to work with their advisors 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.

Students are expected to select at least 12 credit hours in one or several of these areas. The suggested lists of courses are not exhaustive and are intended to provide guidance for the decision that is made collaboratively between the student and their major advisor. 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. Ph.D. 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.

AENG 2920	Design Methodology-Systems Approach (2 hours)
BCHE 2910	Introduction to Biochemical Engineering Design (3 hours)
CSEE 2220	Fundamentals of Logic Design (3 hours)
CSEE 2920	Computer Systems Engineering Design Methodology (2 hours)
CSEE 4230	Embedded Systems Design I (3 hours)
CSEE 4235	Embedded Systems Design II (3 hours)
CSEE 4270	Design of Digital Systems (3 hours)
CSEE 4280	Advanced Digital Design (4 hours)
CVLE 3610	Structural Design (3 hours)
ENGR 1920	Introduction to Engineering (1 hour)
ENGR 4910	Engineering Design Project I (2 hours)
ENGR 4911	Engineering Design Project II (2 hours)
ENVE 2920	Environmental Engineering Design Methodology (3 hours)
ENVE 6435	Natural Resources Engineering (3 hours)
MCHE 1940	Mechanical Engineering Design Studio and Professional Practice (3 hours)
MCHE 3300	Machine Design I (3 hours)
MCHE 3920	Manufacturing and Design Studio (3 hours)

(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.

AENG 2100	Principles of Systems Engineering (3 hours)
CSEE 2200	Introduction to Computer Systems Engineering I (2 hours)
CSEE 2210	Introduction to Computer Systems Engineering II (2 hours)
CVLE 3730	Civil Engineering Project Management (2 hours)
ELEE 1030	Introduction to Electrical Engineering (3 hours)
ENGR 1920	Introduction to Engineering (1 hour)
ENGR 2110	Engineering Decision Making (3 hours)
ENVE 2610	Introduction to Environmental Engineering and Sustainability (3 hours)
ENVE 3520	Engineering Economics and Management (3 hours)
MCHE 1940	Mechanical Engineering Design Studio and Professional Practice (3 hours)

MCHE 2990	Engineered Systems in Society (3 hours)
MCHE 4000	Mechanical Engineering Professional Practice (2 hours)

(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.

BCHE 3520	Mass Transport and Rate Phenomena (3 hours)
CSCI 2611	Discrete Math for Engineers (3 hours)
CVLE 3420	Introduction to Soil Mechanics (3 hours)
ELEE 4020	Electromagnetics (3 hours)
ELEE 4210	Linear Systems (3 hours)
ENGR 2120	Engineering Statics (3 hours)
ENGR 2130	Dynamics (3 hours)
ENGR 3140	Engineering Thermodynamics (3 hours)
ENGR 3150	Heat Transfer (3 hours)
ENGR 3160	Fluid Mechanics (3 hours)
ENVE 3210	Energy Analysis I (3 hours)
ENVE 3220	Energy Analysis II (3 hours)

(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.

AENG 4140	Systems Modeling (3 hours)
BCHE 3420	Kinetics and Reactor Design (3 hours)
BIOE 4740	Biomaterials (3 hours)
CSCI 1301	Introduction to Computing and Programming (4 hours)
CSCI 1302	Software Development (4 hours)
CSCI 1730	Systems Programming (4 hours)
CSCI 2720	Data Structures (4 hours)
CSEE 4210	Digital Signal Processing (3 hours)
CVLE 2210	Principles of Surveying and Transportation (2 hours)
CVLE 2710	Numerical Methods for Engineers (2 hours)
CVLE 3310	Civil Engineering Materials (3 hours)
ELEE 2040	Programming for Engineers (3 hours)
ELEE 3270	Electronics I (3 hours)
ELEE 4220	Feedback Control Systems (3 hours)
ELEE 4230	Sensors and Transducers (3 hours)
ELEE 4240	Introduction to Microcontrollers (3 hours)
ELEE 4270	Electronics II (3 hours)
ELEE 4590	Principles of Communication Systems (3 hours)
ELEE 4710	Fundamentals of Power Engineering (3 hours)
ELEE 4750	Power System Analysis (3 hours)
ENGR 1120	Engineering Graphics and Design (2 hours)

ENGR 1140	Computational Engineering Methods (2 hours)
ENGR 2170	Electrical Circuits (3 hours)
ENGR 2180	Introduction to Modeling of Dynamic Systems (3 hours)
ENVE 3320/3220L	Environmental Engineering – Urban Systems (4 hours)
MCHE 3300	Machine Design I (3 hours)
MCHE 3310	Engineering Materials (3 hours)
MCHE 3920	Manufacturing and Design Studio (3 hours)

Prerequisite requirements for technical grounding courses

In consideration of the individual student's 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.

Examination Process

The following provides further specification of the general examination procedures outlined in the graduate handbook for the Engineering (Ph.D.) program. These examination procedures account for the disciplinary context of social and educational research in the engineering context. More specifically, students are expected to engage in independent scientific work and, over the course of the program, produce high-quality outcomes to the standard of the international research community in their selected focus area. The examination process is designed to be formative and support students to build up to this level of work. With this formative focus in mind, the key milestones of the general Ph.D. examination process are defined as follows. Further details of the examination requirements are outlined in the UGA Graduate School Handbook and the CENGR Graduate Handbook.

Comprehensive exam:
The comprehensive exam (recommended for the end of the 3rd semester) serves a dual purpose: (i) To ascertain the student's disciplinary preparedness for both the dissertation work and an academic or professional career in the chosen focus area. (ii) To guide the student to conceptualize and synthesize their preparatory work towards the dissertation in terms of theoretical framing, literature analysis, research design, and, if applicable, empirical pilot explorations. The questions, expectations, examination format, and time limits are defined by the major professor in consultation with members of the dissertation committee and the student.

Prospectus:
The prospectus builds on the comprehensive exam to develop a feasible, well-scoped, and time-defined project plan for the dissertation study. The prospectus is expected to demonstrate the need for the dissertation study relative to the existing literature; clarify theoretical and methodological bases; lay out the research design; and define the timeline, milestones, and key outcomes of the project.

Publication requirement:
Students are expected to prepare at least one manuscript for a refereed journal. The manuscript should be in the final, submission-ready form. The Major Professor may not agree to schedule a meeting of the Advisory Committee for the purpose of conducting a final examination without a satisfactory draft of the manuscript.

Dissertation:
The dissertation can be completed in manuscript or traditional form based on a consensus between advisory team and the student. A manuscript-style dissertation includes two or more publication-ready manuscripts and additional sections for the introduction, literature review, and concluding chapter, separately from their briefer presentation in each manuscript to allow thoroughness not usually permitted by space limitations in scientific journals.

Approvals on File

Proposal: Area of Emphasis in Engineering Education and Transformative Practice under the major in Engineering (Ph.D.)

College: College of Engineering

Proposed Effective Term: Fall 2018

School/College:

- Engineering Education Transformations Institute Director, Dr. Jo Walther, 3/28/2018
- College of Engineering Associate Dean, Dr. Lawrence Hornak, 3/28/2018
- College of Engineering Dean, Dr. Donald Leo, 3/28/2018

Graduate School:

- Graduate School Dean, Dr. Suzanne Barbour, 4/4/2018