Graduate Handbook
Data Science and Engineering Program

Bredesen Center for Interdisciplinary Research and Graduate Education
The University of Tennessee, Knoxville

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THE UNIVERSITY OF TENNESSEE KNOXVILLE

Bredesen Center
for Interdisciplinary Research
and Graduate Education

OAK RIDGE National Laboratory

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Bredesen Center for Interdisciplinary Research and Graduate Education

Two interdisciplinary doctoral degrees in Energy Science and Engineering (ESE) and Data Science and Engineering (DSE) have been developed at the University of Tennessee in order to educate students in energy and data-related fields that are of increasing importance to the state and the country. The Bredesen Center faculty, based both at the University of Tennessee and Oak Ridge National Laboratory, provide research opportunities in various fields relating to a variety of scientific and engineering challenges. The curriculum includes graduate courses specifically designed for the program of study, but also draws on the graduate offerings of other departments and other universities to provide a broad interdisciplinary foundation for graduate students.

The ESE program was initiated by Governor Phil Bredesen and was funded by the State Legislature of Tennessee in 2010. In 2017, a second PhD program, the Data Science and Engineering PhD, was added. Both degree programs are administered by the Bredesen Center for Interdisciplinary Research and Graduate Education, which has been established by the University of Tennessee, Knoxville and the Oak Ridge National Laboratory.

Lee Riedinger
Director, Bredesen Center
Professor of Physics

Introduction

The Bredesen Center for Interdisciplinary Research and Graduate Education unites resources and capabilities from the University of Tennessee and Oak Ridge National Laboratory to promote advanced research and to provide innovative solutions to global challenges in energy, engineering, and computation.

Seeking to create opportunities for exceptional students to engage in interdisciplinary research and education, the Bredesen Center offers a doctoral degree in the following areas:

- Energy Science and Engineering (ESE)
- Data Science and Engineering (DSE)

Graduate students in these programs perform interdisciplinary research by joining ORNL and UT teams focused on a diverse set of challenges related to energy and to applied data sciences. Graduate coursework specializing in a variety of fields is complemented by studies in policy, entrepreneurship, economics, and outreach to broaden research skills and experiences.

Bredesen Center ESE graduate students further engage in interdisciplinary coursework and research with a focus on science and engineering challenges related to the production, distribution, and consumption of energy. DSE graduate students focus on a core data science curriculum while specializing in a domain science field of research. Additionally, students in both programs participate in broadening curriculum and activities to cultivate skills in policymaking, entrepreneurship, and outreach.

Topical areas of the Bredesen Center programs have been chosen to resonate with Department of Energy priorities and industry needs, integrating graduate coursework from multiple disciplines, while providing deep expertise in a chosen specialty. The partnership with ORNL provides graduate researchers unique resources and advanced opportunities to collaborate on a variety of global energy and computational challenges involving science, engineering, health care, and national security.

The Graduate Program

Admission Requirements

In order to be admitted to the PhD program in data science and engineering, student applicants must fulfill the general admission criteria for the Graduate School of the University of Tennessee, Knoxville. In addition, the student must have a Bachelor of Science degree in either engineering or a scientific field (e.g., analytics, biology, chemistry, computational science, mathematics, physics, statistics, etc.), or the equivalent. Students with other undergraduate degrees may also be admitted on a case-by-case basis by the Bredesen Center Graduate Admissions Committee. Dependent on the student's background, additional coursework may be required to satisfy co- and pre-requisites.

Diversity and Access

Graduate students are nationally recruited for this doctoral program in a large annual campaign. Recruiters from ORNL and the Bredesen Center visit a number of top universities across the U.S. to promote the DSE doctoral program with potential UTK graduate students. Diversity is a strong consideration in this recruitment process. Students are expected to understand and respect the diversity and access policies of UTK and ORNL and to conduct themselves in a professional manner at all times during their time in the program.

Students are expected to complete an orientation session hosted by the Bredesen Center before starting coursework. Additionally, graduate students who will be working at ORNL will be provided with additional information during a separate ORNL orientation. International students must complete any additional paperwork and training required by UTK or ORNL before set deadlines.

Degree Requirements

This graduate program leads to the Doctor of Philosophy (PhD) degree in Data Science and Engineering (DSE). A minimum of 72 credit hours is required beyond the bachelor's degree, exclusive of credit for an MS thesis, and completion of the core requirements as outlined in the section on Course Requirements. Of this number, a minimum of 24 and up to 36 credit hours of course 600 Doctoral Research and Dissertation and **six credit hours of 600-level coursework at UTK will be required, exclusive of Doctoral Research and Dissertation credit.**

In addition to coursework, students must pass a qualifying exam, a comprehensive exam, and a final exam which includes the preparation and defense of a dissertation. The graduate work is performed under the supervision of an advisor/major professor and a graduate committee.

Major Professor (Advisor)

Each graduate student must have an advisor/major professor. This professor advises the student about course selection, supervises the student's research, and facilitates communication within the degree program and/or student's major department, to other departments, and with the Graduate School relative to requirements. A temporary advisor may be assigned to direct the

entering student's work during the period in which the student is becoming acquainted with the institutions and determining the focus of research interests. Once the major professor is determined, the major professor and the student together select a doctoral committee. The student is expected to maintain close consultation with the major professor and other members of the doctoral committee with regard to progress in the program.

Doctoral Committee

The doctoral committees must have at least four members, generally chaired by the major professor that directs the dissertation research of the graduate student. Two committee members must be UTK-based tenured or tenure-track faculty. One member must be outside the Bredesen Center, but of course the two listed above fill this requirement. The other two committee members must have official UTK status, and these two could be adjunct or joint faculty affiliated with the Bredesen Center as ORNL staff, or they could be faculty based in UTK departments. The chair of the doctoral committee must have faculty status in a UTK tenured or tenure-track position or as joint faculty in the Bredesen Center as an ORNL staff member or as a UTC or UTHSC member. An adjunct faculty member cannot serve as the chair of the committee. It is suggested that Bredesen Center graduate students have five members on the dissertation committee, to be sure that there is sufficient coverage of the guidelines described above. The doctoral committee should meet at least annually to ensure sufficient progress of the graduate student towards a PhD.

Admission to Candidacy

Admission to candidacy indicates that the student has demonstrated ability to do acceptable graduate work and that satisfactory progress has been made toward the degree. This action usually connotes that all prerequisites to admission have been completed and a program of study has been approved.

A student may be admitted to candidacy for the doctoral degree after passing the comprehensive examination and maintaining at least a B average in all graduate coursework. Each student is responsible for filing the Admission to Candidacy form.

Summer Registration

Graduate students must take a minimum of three credit hours in the summer, assuming they are engaged in research and/or courses at UT or ORNL. Before passing the qualifying exam, the student should register for DSE 502 – Registration for Use of Facilities to account for research hours. After passing the qualifying exam a student may enroll in DSE 600 – Doctoral Dissertation Research.

Doctoral Dissertation Research Credit (DSE 600)

After passing the qualifying exam, students should enroll in DSE 600 - Doctoral Dissertation Research to register their research hours. Once a student begins taking DSE 600 credit, they must take a minimum of three hours every semester thereafter continuously. Students should begin taking DSE 600 at least in the second summer, assuming the successful completion of the qualifying exam during the academic year.

Graduate Student Examinations

This section provides a description of the graduate student examination requirements for the PhD degree program. Three examinations are required as part of the doctoral program: qualifying examination, comprehensive examination, and defense of dissertation examination.

Qualifying Exam

The qualifying examination is developed, administered, and graded by the faculty (or designated subset of the faculty) of the PhD program under the coordination of the Bredesen Center Director. The Data Science and Engineering doctoral program requires students to be able to investigate and conduct research on a variety of problems. The qualifying examination tests the capabilities of a student through the preparation of a professional quality investigative research report and accompanying presentation that addresses one of several questions in data science and engineering. In case of failure, the candidate may appeal to retake the examination through the Bredesen Center Graduate Curriculum Committee within 30 days of notification of the result. If the appeal is granted, the student must retake the examination at the next offering. The result of the second examination is final. Completion of the qualifying exam enables students to begin working on dissertation research.

Comprehensive Examination

The Comprehensive Examination may be completed as early as the end of the second year following entrance into the PhD program and prior to admission to candidacy. Students should aim to complete the comprehensive exam by the end of the third year and must complete it no later than the first semester of the fourth year unless extenuating circumstances are involved. The timing is late enough in a student's academic program to permit most of his/her graduate course work to be covered on the examination, and early enough to permit modification of the student's program based on the results of the exam.

Two requirements must be satisfied before a student takes the Comprehensive Examination.

1. A written Dissertation Proposal, approved by the major professor, must be submitted to each member of the student's Doctoral Committee two weeks prior to the examination.
2. Each member of the student's Doctoral committee must agree that the student is ready to take the Comprehensive Exam. The committee member will communicate to the major professor when they are satisfied that the student is ready to take the Comprehensive Exam.

The Comprehensive Examination will consist of the student constructing and defending his or her dissertation research proposal to the committee in a format deemed acceptable by the student's Doctoral Committee. Typically, an oral defense is sufficient for this examination, although a written component may be administered by the committee at their discretion. Once the Comprehensive Examination is passed, the student should file for and be admitted to candidacy. At the discretion of the Doctoral Committee, supplemental reexaminations for the Comprehensive Examination and/or proposed dissertation research may be required. In case of

failure, the candidate may not apply for reexamination until the following semester. The result of the second examination is final.

Defense of Dissertation Examination

A doctoral candidate must pass an oral examination on the dissertation. The dissertation, in the form approved by the major professor, must be distributed to the committee at least two weeks before the examination. The examination must be scheduled through the Graduate School at least one week prior to the examination and must be conducted in university-approved facilities. The examination is announced publicly and is open to all students and faculty members. The defense of dissertation will be administered by all members of the doctoral committee after completion of the dissertation and all course requirements. This examination must be passed at least two weeks before the date of submission and acceptance of the dissertation by the Graduate School. The major professor must submit the results of the defense by the dissertation deadline.

Course Requirements

A minimum of 72 hours is required for the DSE doctoral program, and of this total a minimum of 36 hours of coursework is required beyond the BS degree. **The following 36 credit hours of coursework or their equivalent must be completed at a minimum, including the Core Curriculum for Data Science, a Knowledge Breadth Curriculum, a Knowledge Specialization for Domain Science Curriculum, and Seminar Series, as summarized below.** Students with Master's degrees must complete at least 24 credit hours of graduate coursework.

All students must complete a minimum of six hours of 600-level coursework, exclusive of Doctoral Research and Dissertation credit.

Students must maintain full-time status during the Fall and Spring semesters each year, and be engaged in at least three credit hours of dissertation research in the Summer semester. Students are encouraged to engage in summer courses if appropriate. **Each student is required to submit their proposed schedule of courses to the Academic Coordinator, the Academic Advisor, and their major professor before classes begin each semester.** Students that do not have a major professor should consult with the Academic Coordinator of the program in order to construct a course schedule that will sufficiently cover the subject matter related to the student's desired area of research.

A student may begin credited doctoral dissertation research - DSE 600 - after successfully completing the qualifying examination. Students who are deemed qualified by the director of the program may begin taking DSE 600 in the same semester as their qualifying examination. After beginning DSE 600, the student must continue to enroll in DSE 600 for a minimum of three hours every semester until the completion of their degree. A total of 36 credit hours of DSE 600 is required in order to graduate for a student with a Bachelor's degree. A total of 24 credit hours of DSE 600 is required in order to graduate for a student with a Master's degree.

Core Curriculum (21 credits)

Students must complete 21 credit hours in the following core courses (or substitute, approved in advance).

DSE 511
DSE 512
DSE 537
MATH 525 / STAT 563
MATH 526
MSE 510
BZAN 645 / BZAN 646 / ECE 571

Knowledge Breadth Curriculum (6 credits)

The Knowledge Breadth requirement includes six hours of coursework selected from the following areas:

1. Political, social, legal, ethical, and security issues related to energy
2. Entrepreneurship, leadership, and management

Other courses are eligible for consideration of the knowledge breadth requirement and all selections should be approved by the Academic Coordinator in advance of registration for the course.

Knowledge Specialization for Domain Science Curriculum (15 credits)

Students must choose courses from participating departments and approved by the Bredesen Center's Director for Data Science related to the following disciplines.

- Health and Biological Sciences
- Advanced Manufacturing
- Materials Science
- Environmental and Climate Science
- Transportation Science
- National Security
- Urban Systems Science
- Advanced Data Science

Seminar Series (3 credits)

The DSE 599 seminar series will provide topical seminars related to Bredesen Center research themes or knowledge breadth areas. DSE 599 will be offered each fall and spring semester and students must attend at least three semesters of seminar.

Approved Courses

Due to the interdisciplinary nature of this program, The Bredesen Center does not publish a list of pre-approved courses for the specialization or knowledge breadth requirements. Students should consult with their research mentor the appropriate coursework for their particular academic and research goals. Following these discussions students should provide the Academic Coordinator and Academic Advisor a copy of their plan each semester for progress and approval. The Bredesen Center Academic Advisor can also assist in locating courses to satisfy the Graduate School requirements.

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The Bredesen Center is named in honor of Governor Phil Bredesen, who served Tennessee from 2003 to 2011, in recognition of his leadership in education and economic development for the state. In addition his commitment to the Bredesen Center, Governor Bredesen's vision for capitalizing on the great potential of the UT-ORNL partnership resulted in the UT-ORNL Governor's Chairs program, the UT Biofuels Initiative, the Volunteer State Solar Initiative, and the UT-ORNL Joint Institutes for Computational Sciences, Biological Sciences, and Neutron Sciences.