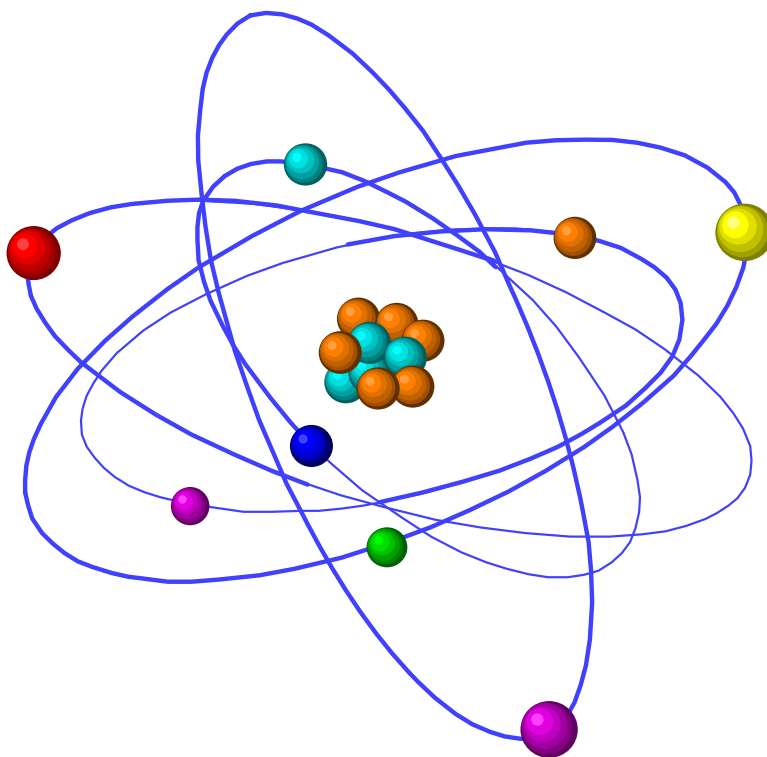


The University of Tennessee

**DEPARTMENT OF  
NUCLEAR ENGINEERING**



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**Graduate Studies**  
in  
**Nuclear and Radiological  
Engineering**

**2009-2010**

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# **GRADUATE STUDIES IN NUCLEAR AND RADIOLOGICAL ENGINEERING THE UNIVERSITY OF TENNESSEE**

## **GRADUATE STUDY AT UT**

The University of Tennessee (UT), with more than 200 years of academic tradition, is a major graduate education center. The University offers master's programs in more than 90 fields of specialization and doctoral programs in more than 50.

The UT Graduate School brings together faculty and students as a community of scholars with a common interest in creative work and advanced study. Programs are available to graduate students interested in full- or part-time study, to professionals interested in continuing education either on campus or via live and interactive distance education, and to scholars pursuing postdoctoral research.

## **THE DEPARTMENT OF NUCLEAR ENGINEERING**

Established in 1957, the UT Department of Nuclear Engineering is one of the oldest and most prestigious programs in the United States. The department's strengths include a well-developed research program, close ties with the Oak Ridge National Laboratory (ORNL), Tennessee Valley Authority (TVA), and several nuclear utilities, international research associations, and attractive graduate assistantships. The faculty is internationally recognized for excellence in research and teaching. The department's graduate program is ranked number twelve in the nation by *U.S. News and World Report* (number eleven among public institutions).

The Department of Nuclear Engineering offers programs leading to the Master of Science and Doctor of Philosophy. Research specializations include applied artificial intelligence, reactor analysis, fuel and waste management, nuclear criticality safety, nuclear reactor dynamics and control, maintenance and reliability engineering, reliability and maintainability, radiological engineering (including health physics), radiation transport, and thermalhydraulics.

The department is housed in the Pasqua Engineering Building, which is devoted exclusively to the Nuclear Engineering Department. This 16,300 square foot building provides offices, classrooms, laboratories, shops, computing facilities, and a

lounge/library for the Nuclear Engineering students and faculty. This facility helps create the cohesive atmosphere, which characterizes the department.

## **RESEARCH OPPORTUNITIES**

The Nuclear Engineering Department's research program provides excellent opportunities for graduate students to participate in state-of-the-art research projects while satisfying their research requirements. The level of research funding and the number of graduate students involved have both grown significantly in recent years. Sponsored research funding now totals over 3 million dollars and enrollment is over 75 graduate students.

The University's association with ORNL, which is operated by UT/Batelle, provides facilities and research opportunities to students and faculty that are not available at any other U.S. university. Research into many nuclear engineering problems may be conducted at ORNL by teams composed of faculty, graduate students, and ORNL personnel. The concentration of nuclear engineering activity in the Knoxville/Oak Ridge area also provides graduate students with a unique opportunity to interact with outstanding researchers and provides access to numerous conferences, colloquia, and seminars held locally.

The department's ties with industry have provided opportunities for students to implement and evaluate new technologies in a real-world environment. These projects have been conducted at TVA, Duke Energy Company, Electricité de France, Florida Power & Light, Northeast Utilities, Emerson Electric, Westinghouse, and many more.

Students in the Nuclear Engineering Department also have the opportunity to work on projects sponsored by the University's Reliability and Maintainability Center and the Scintillation Materials Research Center. These centers are interdisciplinary research organizations that sponsor major research programs throughout the College of Engineering. The Reliability and Maintainability Center focuses on increasing industrial productivity, safety, and efficiency by application of advanced maintenance and reliability engineering methods.

## **CURRENT RESEARCH**

The department is currently involved in several major research projects with over \$3,000,000 in funding. These projects fall into the following categories:

- Signal Validation in Nuclear Power Plants
- Nuclear Criticality Safety
- Digital Signal Processing Techniques
- Control Systems for Advanced Reactors
- Advanced Artificial Intelligence and Neural Computing Methods for Nuclear Power Plants
- Reactor Fault Monitoring and Diagnostics
- Advanced Reactor Design
- Computational Methods Development
- Space Radiation Protection
- Dynamic Modeling of Reactor Systems
- Reactor Noise Analysis
- Advanced Instrumentation
- Advanced Preventive Maintenance Technology Development
- Assessment of Radiological Risks
- Radiation Measurements
- Statistical Analysis of Radiation Effects
- Probabilistic Risk Assessment
- Uncertainty Analysis in Health Physics
- Calibration of Radiation Detectors
- Biokinetic Models for Internal Dosimetry
- Chromosome Radiation Dosimetry
- Kinetic Models for Radionuclide Transport in the Environment
- Space Radiation Shielding and Risk Assessment
- Neutron Capture Therapy
- Cyclotron Target Design for Radioisotope Production

A major program, directed by Dr. Wes Hines with collaboration from Dr. Bob Uhrig, is on Advanced Artificial Intelligence, Neural Computing, and Fuzzy Modeling and Control Methods for Nuclear Power Plants. The purpose of this project is to evaluate these new advanced techniques for application in the nuclear industry and to develop software systems for appropriate applications. This research is providing major new capability for enhancing the operational and safety characteristics of nuclear power plants.

The Department established a graduate concentration in Radiological Engineering (Health Physics) in the fall of 1988. Drs. L.F. Miller, L.W. Townsend, and L.H. Heilbronn manage this program. Students in this concentration take courses in Nuclear Instrumentation, Radiological Assessment, Radiation Protection, and Radiation Biology.

Special Topics courses in microdosimetry, internal dosimetry, uncertainty analysis, and medical imaging are also offered by the Department and are taken by many Radiological Engineering students. Research efforts are generally focused in the areas of radiological assessments, dosimetry, instrumentation, and analysis of radiological data sets with Bayesian methodologies.

A major area of specialization in the graduate program is nuclear criticality safety. Dr. R.E. Pevey and Dr. H.L. Dodds manage this program. The academic and related research activities were developed to provide much-needed graduates to work on criticality safety, primarily at DOE laboratories.

The department was selected by DOE to receive funding (~\$700k over 3 years) for a research project entitled *DESIGN AND LAYOUT CONCEPTS FOR COMPACT, FACTORY-PRODUCED, TRANSPORTABLE, GENERATION IV REACTOR SYSTEMS*. The award was 1 of 10 awards given by DOE from 126 proposals submitted nationally. Generation IV reactor research is the highest visibility research program sponsored by DOE's Nuclear Energy Directorate, and this award puts the department at the forefront of the nation's nuclear energy R&D. The project was a team effort with the department as the lead organization who let subcontracts to MIT, ORNL, Westinghouse, Newport News Shipbuilding, and IPPE in Russia. The majority of the work was done by the UTNE department.

A new area of research is Nuclear Security, which is under the direction of Dr. H.L. Hall, Governor's Chair in Nuclear Engineering. This area promises to be very productive with potential research funding from security organizations such as the U.S. Department of Homeland Security.

These projects illustrate just a few of the research activities in which UT Nuclear Engineering graduate students are involved. Students are assigned to research projects in their areas of interest that will provide them with thesis or dissertation opportunities. Most students serve as graduate research assistants while working on these projects. Thus, the projects provide both income and research experience for the students.

## **FINANCIAL ASSISTANCE**

The University is committed to providing quality education at a reasonable cost, and a number of programs have been developed to help graduate students finance their studies.

The department offers Graduate Research Assistantships (GRA). GRA positions include monthly stipends of \$1,800 for beginning M.S. candidates, \$1,900 after receiving the M.S. degree, and \$2,000 for Ph.D. candidates who have passed the Ph.D. Examination. These rates result in annual stipends of \$21,600 (for beginning M.S. candidates) to \$24,000 (for Ph.D. candidates who have passed the first part of the comprehensive examination). Several Fellowships, Graduate Assistantships, and Graduate Teaching Assistantships with competitive stipends are available for appropriately qualified students. All types of assistantship appointments include waiver of tuition and maintenance fees, but students must pay the activity fee (\$150 per semester), the technology fee (\$100 per semester), and the engineering differential fee (\$200 per semester).

Also, there are excellent fellowship opportunities for nuclear engineering graduate students offered by national organizations such as the Department of Energy, the American Nuclear Society, and the National Academy for Nuclear Training. The Nuclear Engineering Department provides information and assistance in applying for these fellowships.

## **ADMISSION**

Admission to the program requires a minimum grade-point average of 2.7 out of a possible 4.0, or a 3.0 during the senior year of undergraduate study. International students must have at least the equivalent of a B average on undergraduate courses and must have a score of at least 550 on the paper based Test (213 on the computer based test) of English as a Foreign Language (TOEFL). It should be noted, however, that meeting these minimum standards does not guarantee admission to the program. Students must submit an application for admission to the Graduate School (application forms are available online). Applicants must also take the GRE examination and submit test scores. Applications for financial assistance (GRA, GA, or GTA) must be sent to the Nuclear Engineering Department.

## **PROGRAMS OF STUDY**

The Department of Nuclear Engineering offers programs leading to the Master of Science and Doctor of Philosophy degrees, and two Graduate Certificates. Students may elect a traditional nuclear engineering program focusing on fission energy, or a radiological engineering concentration, which prepares students for careers in the radiation safety field (health physics) and medical physics. Both programs are designed for graduates of accredited undergraduate programs in engineering, physics, chemistry, or mathematics.

All students will be advised regarding coursework, including possible remedial coursework, after being admitted. In addition, students without a B.S. degree in nuclear engineering, or the equivalent, must take 433 (Radiation Protection) and 470 (Nuclear Reactor Theory I), both of which may be taken for graduate credit. The department head is the contact for all interested students, both those with nuclear engineering degrees and those from other disciplines. More detailed information about the Department of Nuclear Engineering is available on the web at <http://www.engr.utk.edu/nuclear/>.

The Graduate Catalog located at <http://catalog.utk.edu/index.php?catoid=2> provides the requirements for graduate study in Nuclear Engineering including the M.S. program, the Ph.D. program, and both graduate certificates. Each applicant will be advised as to the necessary prerequisite courses before he/she enters the program.

## **TYPICAL STUDENT PROGRAMS**

A typical M.S. program in traditional nuclear engineering is as follows:

### **Fall Semester**

- (3) NE 571 Reactor Theory and Design
- (3) Math, Statistics, or Computer Science course
- (3) Elective (NE or related field)

Begin work as a GRA, GA, or GTA. Students will begin investigations of a thesis topic or will begin work on an engineering practice project.

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9 semester hours

### **Spring Semester**

- (3) NE 572 Nuclear System Design
- (3) Math, Statistics, or Computer Science Course
- (3) Elective (NE or related field)
- (3) NE 500 or NE 598 - Research (GRA students generally satisfy research requirements through work on a research contract or grant).

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12 semester hours

**Summer Semester**

- (3) Elective (NE or related field)
- (9) NE 500 or NE 598 - Research

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12 semester hours

**Fall Semester**

- (3) Elective (NE or related field)
- (3) NE 500 or NE 598 - Research

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6 semester hours

It should be noted that every research topic is different, and the time required for completion varies.

A typical M.S. program for Radiological Engineering is as follows:

**Fall Semester**

- (3) NE 551 Radiation Protection
  - (3) Mathematics, Statistics, or Computer Science
  - (3) NE 490 Radiation Biology
- Begin work as a GRA, GA, or GTA. Students will begin investigations of a thesis topic or will begin work on the first engineering practice problem.

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9 semester hours

**Spring Semester**

- (3) NE 542 Management of Radioactive Materials
- (3) Math, Statistics, or Computer Science Course
- (3) NE 552 Radiation Monitoring and Dose Assessment
- (3) NE 500 or NE 598 - Research (GRA students generally satisfy thesis research requirements through work on a research contract or grant).

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12 semester hours

**Summer Semester**

- (3) Elective (NE or related field)
- (9) NE 500 or NE 598 - Research

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12 semester hours

### **Fall Semester**

- (3) NE 550 Nuclear Instrumentation
- (3) NE 500 or 598 - Research

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6 semester hours

### **COURSE DESCRIPTIONS**

The course descriptions of all courses that are available for graduate credit and that are offered by the department are listed in the Graduate Catalog at <http://catalog.utk.edu/index.php?catoid=2>.

### **GRADUATE CREDIT FOR UNDERGRADUATE COURSES**

400-level courses in nuclear engineering may be used for graduate credit. However, at least two-thirds of the minimum required hours in the M.S. program must be taken in courses numbered 500 or above.

### **ACADEMIC COMMON MARKET**

An agreement among southern states for sharing graduate programs allows legal residents of some states to enroll in certain programs at UT on an in-state tuition basis. The M.S. program in Nuclear Engineering is available to residents of the states of Arkansas and Mississippi. Other states that do not have a graduate nuclear engineering program are also eligible to participate.

Additional information may be obtained from the Administrative Services Assistant in the Office of Graduate Admissions.

## **DISTANCE EDUCATION**

The Nuclear Engineering Department at the University of Tennessee offers three graduate programs that are available to distance students: the MS degree in nuclear engineering (see <http://www.anywhere.tennessee.edu/ne/default.htm>) and two Graduate Certificate Programs, one in Nuclear Criticality Safety and the other in Maintenance and Reliability Engineering. The department also participates in the Reliability and Maintainability M.S. program, which is an interdisciplinary program in the UT College of Engineering and is also available via distance.

Most of the courses in the graduate programs are delivered synchronously (i.e., live and interactive) to the student's desktop computer via the Internet using CENTRA (see <http://www.centra.com>). The CENTRA software permits real time oral communication between instructor and students as well as real time oral communication between the students. This interactive oral communication is usually accompanied by video visual aids such as PowerPoint slides and HTML documents. The synchronous classes are also available asynchronously (i.e., saved on a server) after synchronous delivery to accommodate students who must occasionally miss class due to work related travel.

The MS program for distance students is the same as our traditional MS program for local students, but with fewer courses offered. The MS program requires eight 3-hour graduate courses: four Nuclear Engineering (NE) courses, two courses in a related technical discipline (or two more NE courses), and two courses in mathematics or

statistics. In addition, at least six hours of research or engineering practice are required for a total MS requirement of at least 30 hours. Up to one-third of the credit hours for the MS degree can be transfer credit from another accredited institution.

MS distance students must also register for at least three hours of research or engineering practice during any semester in which research or engineering practice is conducted to satisfy degree requirements. Proposed projects, either thesis research or engineering practice projects, may (or may not) be related to the student's current job, but must be approved *a priori* by the student's major professor and graduate committee. To obtain approval, a brief proposal written by the student must be submitted to and approved by the student's major professor and graduate committee at the beginning of the proposed project. The student must also write brief monthly progress reports, which are submitted to and approved by the student's major professor. The student may also have an on-site advisor or mentor to help direct the student's work along with the overall supervision provided by the major professor. However, acceptance of the student's work in satisfying degree requirements is solely the responsibility of the student's major professor and graduate committee. Good research and engineering practice projects frequently lead to external publications that are co-authored by the student, the on-site advisor, and the major professor. At the conclusion of the MS program, students come to the UT main campus to defend their work, both coursework and thesis or engineering practice project report(s), in a comprehensive oral exam in front of their major professor and graduate committee.

Each Certificate Program consists of four 3-hour graduate courses and does not include a requirement for research or engineering practice. The four courses required for the Nuclear Criticality Safety Certificate are Introduction to Nuclear Criticality Safety,

Selected Topics in Nuclear Criticality Safety, Monte Carlo Analysis, and one of the following three elective courses: Undergraduate Reactor Theory, Graduate Reactor Theory and Design, or Graduate Reactor Shielding. The four courses required for the Certificate in Reliability and Maintainability Engineering are Introduction to Maintenance Engineering, Introduction to Reliability Engineering, and two elective courses selected from the following list: Advanced Monitoring and Diagnostics, Process System Reliability and Safety, Mechanical Vibrations, Reliability Centered Maintenance, and Statistical Methods in Industrial Engineering. The Reliability and Maintainability Certificate program is actually a college-wide program, which currently includes elective courses in mechanical engineering and industrial engineering as well as nuclear engineering. Any of the courses in the two Certificate programs may also be used to satisfy MS degree requirements.

Admission requirements are the same for both local and distance graduate programs; namely, a B.S. in any engineering discipline, physics, chemistry, or mathematics from an accredited program with at least a 3.0/4.0 GPA. Students may be required to take certain remedial courses without graduate credit depending on their educational background. The recommended course of study for each individual student is determined by an advising conference with the student and depends on the student's professional interests, academic background, and work experience. The cost for either of the distance programs is the standard fee schedule for the Graduate School at the University of Tennessee and is described in detail in the current Graduate Catalog. More detailed information about the courses and the web delivery technology is available at <http://www.anywhere.tennessee.edu/ne/default.htm>.

Finally, students who successfully complete any of our graduate programs will gain state-of-the-art knowledge in their chosen field, be better qualified to work as professionals, and increase their value to their current employer and to perspective new employers. More importantly, students will have the personal satisfaction and enjoyment of learning new concepts and developing new skills in an exciting field of national and international importance. For additional information, contact University Outreach and Continuing Education at <http://www.outreach.utk.edu>.

## **FACULTY**

For a listing of our current faculty and their research interests, please refer to our web pages at <http://www.engr.utk.edu/nuclear>.

## **KNOXVILLE AND THE UNIVERSITY**

UT is located in a metropolitan area of more than 500,000 people. The University and the City of Knoxville offer nationally recognized cultural and entertainment events, large shopping malls, and many fine restaurants, yet the scenic beauty and recreational activities offered by the Great Smoky Mountains and several TVA lakes are within an hour's drive of the campus.

The University's more than 300 academic, social, and recreational organizations give students the opportunity to participate in small groups within the larger environment. The diverse activities offer many opportunities to learn more about other life-styles and cultures and to meet and develop friendships with students and faculty who share similar interests.

Recent expansion of the library has given the campus one of America's most technologically advanced facilities for scholarly research. Located in the center of campus, the library holds more than two million volumes and offers state-of-the-art audiovisual service and on-line database reference searching.

The University offers a variety of housing for both single and married students. University-owned housing is located in several residential areas of the city. The cost of university housing is described at <http://uthousing.utk.edu/>. An off-campus housing office is available to assist students who wish to live in non-University housing, which is usually more expensive than university housing.

#### **A COMMITMENT TO EXCELLENCE**

The University challenges its students and faculty to excel in scholarship, research, and scientific investigation, and in contribution to economic, social, and cultural development. UT is committed to providing a quality educational experience and preparation for a productive future.

#### **FOR ADDITIONAL INFORMATION, CONTACT**

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Office of Graduate Admissions and Records  
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(865) 974-3251

Recently updated information is available on the Internet at [www.utk.edu](http://www.utk.edu) and at [www.engr.utk.edu/nuclear](http://www.engr.utk.edu/nuclear).

The University of Tennessee does not discriminate on the basis of race, sex, color, religion, national origin, age, handicap, or veteran status in provision of educational opportunities or employment opportunities and benefits.

UT does not discriminate on the basis of sex or handicap in the education programs and activities which it operates, pursuant to requirements of Title IX of the Educational Amendments of 1972, Public Law 92-318; and Section 504 of the Rehabilitation Act of 1973, Public Law 92-112; respectively. This policy extends to both employment and admission to the University.

Inquiries concerning Title IX and Section 504 should be directed to the Office of the Director of Affirmative Action, 403-C Andy Holt Tower, The University of Tennessee, Knoxville, Tennessee 37996-0144, (865) 974-2498. Charges of violation of the above policy also should be directed to the Office of the Director of Affirmative Action.

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## APPLICATION FORMS

*Please note:*

1. Graduate Applications for Admission, which are available online at <http://admissions.utk.edu/graduate/>, should be **sent directly to the University of Tennessee Graduate School**.
2. Applications for assistantships, which are available online at <http://www.engr.utk.edu/nuclear/Application.pdf>, must be submitted directly to the Nuclear Engineering Department. Three persons must also send Confidential Rating Forms to the Department.