The college had its beginnings in the university when surveying was introduced into the curriculum in 1838. The first two professional degrees, Civil Engineer and Mining Engineer, were established in 1879 at the same time that the Board of Trustees authorized the establishment of a graduate school. Known as Mechanic Arts originally, Engineering became a college in 1904.

The purpose of the College of Engineering is to educate men and women to the high levels of research, technical competence, and social understanding that will enable them to fulfill their responsibilities as professional engineers.

Graduate programs of the College of Engineering provide opportunities for advanced study leading to the Master of Science and the Doctor of Philosophy degrees. For a listing, consult majors and degrees available on the chart at the front of this catalog.

Facilities for research and service include the Center for Homeland Security and Counterproliferation, Center for Materials Processing, Center for Transportation Research, Maintenance and Reliability Center (MRC), and the Scintillation Materials Research Center (SMRC).

MASTER OF SCIENCE
RELIABILITY AND MAINTAINABILITY ENGINEERING MAJOR

A Master of Science degree with a major in reliability and maintainability engineering is offered through an interdepartmental program. Available concentrations are aerospace engineering, biomedical engineering, chemical engineering, computer engineering, electrical engineering, industrial engineering, mechanical engineering, and nuclear engineering. Both thesis and non-thesis options are available. The program can be completed on campus or through distance delivery.

Admission

Individuals seeking admission to the Master of Science program with a major in reliability and maintainability engineering must first be admissible to the University of Tennessee, Knoxville, and then admitted to a department offering a concentration within the MS with a major in reliability and maintainability engineering.

Applicants for admission to the MS program with a major in reliability and maintainability engineering are expected to have earned a bachelor's degree from an accredited undergraduate program in engineering or physics. Students from other appropriate disciplines (e.g., chemistry, mathematics, etc.) can be admitted but additional engineering courses may be required. Entering students must have, as a minimum, competency in mathematics through ordinary differential equations. The Reliability and Maintainability Engineering Program Coordinator is the contact for all students interested in the reliability and maintainability engineering major.

Requirements

Students, with the concurrence of their graduate committee, may choose between a thesis option and a non-thesis project option. The chosen coursework must be approved by the graduate student's major professor and committee. After the completion of the formal program coursework and research, the student must pass an oral examination conducted by his/her graduate committee. The committee will include the student's major professor, the Reliability and Maintainability Engineering Program Coordinator (or appointee), and another faculty member at the rank of assistant professor or above.

At least two-thirds of the minimum required hours must be taken in courses numbered at or above the 500 level.

Thesis Option (30 hours)

- Twelve hours of core courses chosen from the list below.
- Three hours of elective courses chosen from the list below.
- Six hours in statistics chosen from the list below.
- Three hours in engineering, statistics, business management, or a related field.
- Master's thesis. Six hours through the department of the major professor.
- A final oral examination covering the thesis and related coursework. The final oral examination must be at the University of Tennessee Knoxville campus.

Non-Thesis Option (30 hours)

- Twelve hours of core courses chosen from the list below.
- Six hours of elective courses chosen from the list below.
- Six hours in statistics chosen from the list below.
Three hours in engineering, statistics, business management, or a related field.

- Project in lieu of thesis (3 hours). The course will be supervised by the student’s committee. A written project proposal describing what the student will do in the course must be approved and submitted in advance to the student’s graduate committee. A written final report is required. The project course may be taken through the major professor’s department – Chemical Engineering 580, Electrical and Computer Engineering 501, Engineering Science 590, Industrial Engineering 501, Mechanical Engineering 590, or Nuclear Engineering 598.

- A final oral examination covering the project and related coursework. The final oral examination must be at the University of Tennessee Knoxville campus.

**Reliability and Maintainability Engineering Core Courses**

- Statistics 560; Industrial Engineering, Mechanical Engineering or Nuclear Engineering 483*; Industrial Engineering, Materials Science and Engineering, Mechanical Engineering, or Nuclear Engineering 484*; Chemical Engineering or Nuclear Engineering 585*.

**Reliability and Maintainability Engineering Electives**

- Biomedical Engineering, Chemical Engineering, Electrical and Computer Engineering, Materials Science and Engineering, or Mechanical Engineering 507; Chemical Engineering or Industrial Engineering 561; Electrical and Computer Engineering 503 or 504; Industrial Engineering 516 or 517; Biomedical Engineering, Engineering Science, Mechanical Engineering 534*; or Nuclear Engineering 579*.

**Statistics Electives**


* Currently offered through distance.

**DUAL MS-MBA**

The College of Business Administration and the College of Engineering offer an integrated program leading to the conferral of the Master of Business Administration degree with a major in business administration (concentration in operations management) and the Master of Science degree in one of the following engineering majors – aerospace, biomedical, chemical, computer, electrical, engineering science, industrial, materials science, mechanical, and nuclear engineering (refer to each major for specific information and requirements).

The establishment of the dual degree program addresses the critical need for personnel trained in both engineering and management who can integrate an increasingly complex body of knowledge for rapid introduction of new products to the marketplace. The objective of the dual degree program is to prepare graduates to take a leading management role in companies that must react quickly to a dynamic market where forces of competition require rapid changes via short cycles in design, manufacturing, and product development. Since the development of a commercial product is a central part of the program, the MS-MBA is also for students who wish to become entrepreneurs.

**Admission**

Applications are accepted for fall semester only. Applicants for the MS-MBA program must make separate application to, and be competitively and independently accepted by, the Office of Graduate and International Admissions for the Master of Business Administration degree program and the office of Associate Dean for Student Affairs at the College of Engineering. Students will initially apply for the MBA program, indicating on their application the intent to pursue the dual MS-MBA program and the appropriate engineering major (refer to the MBA program for separate instructions). Students accepted for both the MBA and the MS with a major in one of the participating engineering majors will be assigned to Dual Degree Program Committee advisors, who will be responsible for course approval and supervision of the students’ progress through the dual program.

Applications by U.S. citizens and permanent residents received after the MBA application deadline (March 1) will be considered as space allows. Additional information is required and different application dates are established by the Office of Graduate and International Admissions for international students.

**Requirements**

All engineering students enrolled in the program must complete common coursework designed to provide them with an integrated, multidisciplinary teamwork experience. The MBA curriculum in product development and manufacturing consists of 30 hours of common coursework in the College of Business Administration and 12 hours of common coursework in the College of Engineering. Engineering common coursework includes a culminating 3-hour integrated project course requiring a comprehensive report, and a final examination as required by the Dual Degree Program Committee, to be taken during the first session of summer following the second year.

During the second year, dual degree candidates will take courses in their engineering major. The coursework for each option is designed to provide students with a concentration in their major and advanced skills to accomplish their teamwork assignments.

The dual degree candidate must satisfy the curriculum and graduation requirements of both the engineering major being pursued and the College of Business Administration. Students withdrawing from the dual degree program before completing both degrees will not receive credit toward graduation in either degree program for courses taken in the other degree program, except as such courses qualify for credit without regard to the dual degree program. The MS and the MBA degrees will be awarded upon successful completion of the requirements of the dual degree program.

**Approved Dual Credit**

A maximum of 15 hours of the engineering courses may be counted toward the MBA degree program.

**GRADUATE CERTIFICATE IN RELIABILITY AND MAINTAINABILITY ENGINEERING**

The College of Engineering offers a graduate certificate in reliability and maintainability engineering. The program is designed primarily for part-time students in that all of the courses are available through distance education (see http://www.any-where.tennessee.edu). The 12-hour certificate is earned by completing 483 and 484, which are cross-listed among all participating departments in the College of Engineering, plus two elective courses selected from a list of courses provided by the participating departments – Chemical Engineering, Industrial and Information Engineering, Mechanical, Aerospace, and Biomedical Engineering, and Nuclear Engineering. Currently, the available elective courses are Chemical Engineering 561, Industrial and Information Engineering 516 and 591, Mechanical Engineering 534 and 599, and Nuclear Engineering 579 and 585. The selection of elective courses is determined through an advising conference with each individual student, and is based on the student’s personal interests, academic background, and work experience. Applicants must meet the minimum criteria established by the Graduate Council.

**DOCTOR OF PHILOSOPHY REQUIREMENTS**

Detailed minimum university requirements for the doctoral degree are listed at the front of the catalog under the Graduate School. Most departments have additional specific requirements listed in their portion of the catalog. The College of Engineering requires a minimum of 36 hours of graduate coursework. Departments, programs, and/or dissertation committees may impose a
higher minimum. A minimum of 24 hours of Doctoral Research and Dissertation and a minimum of 72 hours of graduate credit (coursework plus research and dissertation) are required.

PROGRAMS AT THE UT SPACE INSTITUTE
At the University of Tennessee Space Institute near Tullahoma, graduate-level courses are offered in engineering fields such as aerospace, chemical engineering, electrical engineering, engineering science, industrial engineering including engineering management, materials science and engineering, mechanical engineering, and mathematics and physics. All programs lead to the Master of Science degree. Also, PhD programs are available in many of these fields. Information may be obtained from the Registrar, The University of Tennessee Space Institute, Tullahoma, Tennessee 37388.

DEPARTMENT OF CHEMICAL ENGINEERING
http://www.che.utk.edu/
Bamin Khomami, Head
Paul D. Frymier, Graduate Liaison

Professors
Blenkowski, P.R., PhD .................................... Purdue
Counce, R.M., PhD ....................................... Tennessee
Khomami, B., PhD ....................................... Iowa
Sheth, Atul C. (UTSI), PhD ............................. Northwestern

Associate Professors
Bruns, D.D., PhD ........................................ Houston
Edwards, B.J., PhD ....................................... Delaware
Frymier, P.D., PhD ....................................... Virginia
Keffer, D.J., PhD .......................................... Minnesota
Petrovan, S. (Research), PhD ......................... Iasi Tech (Romania)
Wang, T.W., PhD ........................................ Massachusetts Institute of Technology
Weber, F.E., PhD .......................................... Minnesota

Adjunct Faculty
Collier, J.R., PhD ........................................ Case Institute of Technology
Steele, W.V., PhD ....................................... Queens (Belfast)

Emeriti Faculty
Holmes, J.M., PhD .................................... Tennessee
Moore, C.F., PhD, PE .................................. Louisiana State
Prados, J.W., PhD, PE .................................. Tennessee

MAJOR DEGREES
Chemical Engineering
Advanced control systems concentration
Chemical bioengineering concentration
Chemical engineering concentration
Polymer science and engineering concentration

Chemical Engineering
MS-MBA
Reliability and Maintainability Engineering
Chemical engineering concentration

Core Graduate Classes in Chemical Engineering
A graduate degree in chemical engineering requires the mastery of the core fundamentals of the discipline. These fundamentals are represented by five core courses – 505, 531, 547, 548, and 551. Both the master’s (thesis and non-thesis) and doctoral degrees in chemical engineering require the successful completion of these core courses.

Additional Coursework
In addition to the core classes, supplementary coursework appropriate for each graduate degree will be needed. The coursework beyond the core courses is determined in consultation with the student’s advisor and dissertation or thesis committee and must be approved by the committee and the department head.

MASTER OF SCIENCE
CHEMICAL ENGINEERING MAJOR
Requirements
Thesis Option
The standard master’s program includes a thesis and leads to the Master of Science. Minimum departmental requirements are as follows.

- A total of at least 21 semester hours in graduate-level courses (excluding 500 and 501) in chemical engineering and related areas beyond the baccalaureate. These courses must include the five core courses.
- Research and a thesis to give at least 9 hours of credit in 500.
- Active participation in graduate seminars in the department. Resident students must register for 501 every semester it is offered.
- A final oral examination covering the thesis and related fields and graduate coursework.

Non-Thesis Option
Any candidate may apply for a non-thesis option. Upon acceptance, a supervisory committee of three will be appointed. At least two members of the committee will be from the faculty in the department. The requirements for completion of the non-thesis option are:

- Completion of a total of 30 hours of graduate coursework. At least 18 of those hours must be in the department.
- Satisfactory completion of a culminating experience. Chemical Engineering 580 (Critical Review) as this course shall include a comprehensive exam administered by the faculty committee.

DUAL MS-MBA
Chemical Engineering Major

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<td>Chemical Engineering 594 ............................................................ 3</td>
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</tbody>
</table>

* The departmental courses include the five required departmental core courses.
DOCTOR OF PHILOSOPHY
CHEMICAL ENGINEERING MAJOR

Requirements

Students may apply directly to the PhD program either with or without having completed a master’s thesis. Students proceeding directly to the PhD program from a baccalaureate degree should submit evidence of outstanding performance in a rigorous undergraduate program and the ability to perform independent research at the doctoral level.

A total of 72 hours beyond the bachelor’s degree are required for the PhD. These consist of coursework hours and research and dissertation hours (Chemical Engineering 600). Specifically, the departmental requirements consist of the satisfactory completion of:

- A minimum of 36 semester hours in graduate-level courses (excluding 600) in chemical engineering and related fields beyond the baccalaureate. These courses must include the five core courses and at least 6 hours of courses at the 600 level from the University of Tennessee, Knoxville.
- A comprehensive examination consisting of a written part and an oral part. The written part covers the core fundamentals of the program. The defense of the dissertation proposal constitutes the oral portion of the exam.
- A minimum of 24 hours of research and dissertation credit in Chemical Engineering 600. Registration must be continuous from the time research begins. (See the Continuous Registration requirement in the Graduate School section of this catalog.)
- Successful oral defense of the dissertation before the student’s dissertation committee.
- Active participation in graduate seminars conducted by the department. Resident students must register for 501 every semester offered.

Intercollegiate Graduate Minor in Computational Science (IGMCS)

The Department of Chemical Engineering participates in the intercollegiate graduate minor in computational science (IGMCS) program. Any student pursuing a Master’s or PhD with a major in chemical engineering can receive a minor in computational science by completing the appropriate IGMCS requirements. For further information see the description of the IGMCS listed under the Department of Computer Science. The Department of Chemical Engineering also contributes courses to the IGMCS program curriculum.

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

http://www.engr.utk.edu/civil/
Gregory D. Reed, Head
Richard M. Bennett, Graduate Liaison

Professors
Bennett, R.M., PhD, PE ........................................ Illinois
Burdette, E.G. (Fred N. Peebles Professor), PhD, PE ........................................ Illinois
Chatterjee, A., PhD, PE ........................................ North Carolina State
Davis, W.T. (Associate Dean), PhD ........................................ Tennessee
Deatherage, J.H., PhD, PE ........................................ Tennessee
Drumm, E.C., PhD, PE ........................................ Arizona
Penumadu, D., PhD ........................................ Georgia Tech
Reed, G.D., PhD, PE ........................................ Arkansas
Urbanik, T. (Condra Professor and Goodrich Chair), PhD, PE ........................................ Texas A&M

Associate Professors
Cox, C.D. (Research Fellow), PhD, PE ........................................ Penn State
Gentry, R., PhD, PE ........................................ Memphis
Han, L.D., PhD ........................................ California (Berkeley)
Ma, Z., PhD, PE ........................................ Nebraska

Miller, T.L., PhD, PE ........................................ Tennessee
Richards, S.H., PhD, PE ........................................ Tennessee
Robinson, K.G., PhD ........................................ Virginia Tech

Assistant Professors
Agnihotri, S., PhD ........................................ Illinois
Huang, B., PhD, PE ........................................ Louisiana State
Schwartz, J., PhD, PE ........................................ Illinois
Zhao, Q., PhD ........................................ California (Berkeley)

MAJORS

Civil Engineering

Construction engineering concentration
Environmental engineering concentration
Geotechnical/Materials engineering concentration
Public works engineering concentration
Structural engineering concentration
Transportation engineering concentration

Environmental Engineering

Air quality concentration
Environmental risk assessment concentration
Mixed waste management concentration
Waste management concentration
Water quality concentration
Water resources concentration

MASTERS OF SCIENCE

The Master of Science programs in civil engineering and environmental engineering are offered to graduates of recognized undergraduate curricula. It is required that all applicants to the degree programs submit scores from the General Graduate Record Examination (GRE). Both degree programs have thesis and non-thesis options. It is the policy of the department that students supported by university-related financial aid complete an integrated project, which is defined as a Thesis (Civil Engineering/Environmental Engineering 500) or Special Problems (Civil Engineering/Environmental Engineering 590). The appointment letter may specify which of the two options must be selected.

CIVIL ENGINEERING MAJOR

Departmental requirements are that for a major in civil engineering, the bachelor’s degree must be in civil engineering, or certain undergraduate prerequisite courses must be taken before Admission to Candidacy. The Department of Civil and Environmental Engineering offers both thesis and non-thesis options for the Master of Science with a major in civil engineering. Either option must be approved by the student’s major professor.

Thesis Option
A minimum of 30 semester hours of approved graduate courses, including 6 hours of thesis, is required.

Non-Thesis Option
A minimum of 33 semester hours of approved graduate courses, which may include a 3-hour special problems course to be completed under the direction of the student’s major professor, is required.

ENVIRONMENTAL ENGINEERING MAJOR

For the Master of Science with a major in environmental engineering, normally a bachelor’s degree in a field of engineering is required. For a student who does not have an engineering background, the following minimum prerequisite courses will be required – Engineering Fundamentals 151, 152; Statistics 251; Civil Engineering 380, 390, and 395 or 416; Mathematics 141, 142, 231, 241; Chemistry 120, 130. In general, these must be completed with a B average before courses for graduate credit can be taken. The Department of Civil and Environmental Engineering offers both thesis and non-thesis options for the Master of Science with a major in environmental engineering. Either option must be approved by the student’s major professor.
Thesis Option
A minimum of 30 semester hours of approved graduate courses, including 6 hours of thesis and a minimum of 15 semester hours of approved environmental engineering coursework, is required. A minor may be selected but is not required.

Non-Thesis Option
A minimum of 33 semester hours of approved graduate courses is required. This may include a 3-hour special problems course to be completed under the direction of the student’s major professor. The major includes a minimum of 18 semester hours of approved environmental engineering coursework, including a minimum of 9 semester hours of advanced engineering design courses selected from a list provided by the student’s committee. A minor may be selected but is not necessarily required.

DOCTOR OF PHILOSOPHY

CIVIL ENGINEERING MAJOR
A graduate program leading to the Doctor of Philosophy is offered with a major in civil engineering. It is required that all applicants to the degree programs submit scores from the General Graduate Record Examination (GRE). Specific departmental requirements for the PhD include the following:

- A minimum of 72 semester hours beyond the bachelor’s degree, exclusive of credit for the MS thesis. Of this number, a minimum of 24 hours in 600 Doctoral Research and Dissertation will be required. It is expected that the research work will be in journal publication form prior to approval of the dissertation.

- A minimum of 18 semester hours of graduate courses in civil engineering or environmental engineering, exclusive of thesis or dissertation credit, at least 6 hours of which must be 600-level courses.

- Additional coursework in civil engineering, environmental engineering, or related scientific and engineering fields, amounting to a minimum of 18 semester hours, subject to approval by the student’s faculty committee. These related fields will normally include such disciplines as mechanics, chemistry, mathematics, microbiology, physics, and other engineering fields. A minimum of 6 semester hours of mathematics will be required beyond the civil engineering undergraduate requirements.

- At the discretion of the student’s dissertation committee and depending on the student’s background, more than 36 hours of courses may be required.

- A maximum of 24 course hours from the master’s degree may be used to satisfy the course requirements for the PhD.

- One foreign language if the student’s faculty committee feels that a reading knowledge of a foreign language is crucial to the student’s research efforts.

- Upon completion of at least one-half of all coursework, each student must pass a comprehensive examination.

After completion of the dissertation, prior to graduation, each student must pass a dissertation defense examination administered by a faculty committee.

Environmental Policy Minor
The department participates in a program designed to give graduate students an opportunity to develop an interdisciplinary specialization in environmental policy. See Department of Political Science for program description.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

http://www.ece.utk.edu/

Samir El-Ghazaly, Head
Jack S. Lawler, Graduate Liaison

Professors
Abidi, M., PhD ................................. Tennessee
Birdwell, J.D., PhD .......................... Massachusetts Institute of Technology
Bomar, B.W. (UTSI), PhD ........................... Tennessee
Bouldin, D.W., PhD ................................... Vanderbilt
El-Ghazaly, S.M., PhD ........................ Texas
Kuo, W. (Dean and University Distinguished Professor), PhD ........................ Kansas State
Lawler, J.S., PhD .................................. Michigan State
Pace, M.O., PhD .................................. Georgia Tech
Pujiol, S.A. (UTSI), PhD .......................... Vanderbilt
Roberts, M.J., PhD .............................. Tennessee

Associate Professors
Blalock, B.J., PhD ................................. Georgia Tech
Cirilly, P.B., PhD ............................... New Mexico State
Fathy, A., PhD ................................. Polytechnic Institute of New York
Islam, S.K., PhD ................................. Connecticut
Peterson, G.D., DSc .............................. Washington (St. Louis)
Qi, H., PhD ...................................... North Carolina State
Smith, L.M. (UTSI), PhD ........................ Tennessee
Tolbert, L.M., PhD, PE ............................ Georgia Tech

Assistant Professors
Djouadi, S. M., PhD .......................... McGill (Canada)
Ehman, I., PhD ............................... Ben-Gurion (Israel)
Farquhar, E.D., PhD .............................. Georgia Tech
Ferdjallah, M., PhD ............................. Texas
Kong, S.G., PhD ................................. USC
Li, F., PhD ...................................... Virginia Tech
Wang, X., DSc ................................. Washington (St. Louis)
Wu, J., PhD .............................. Notre Dame

Emeriti Faculty
Alexeff, I., PhD, PE ............................... Wisconsin
Gonzalez, R.C., PhD ........................ Texas A&M
Green, W.L., PhD ................................. Texas A&M
Roth, J.R., PhD ................................. Cornell

MAJORS DEGREES

Computer Engineering
MS, PhD

Computer architecture concentration
Networks concentration
Computer vision concentration
Data fusion concentration
Data structures concentration
Data visualization concentration
Embedded systems concentration
Image processing concentration
Information systems concentration
VLSI system design concentration

Electrical Engineering
MS-MBA

Circuit theory concentration
Communication theory concentration
Computers concentration
Control systems concentration
Electro-optics concentration
Electromagnetic theory concentration
Plasma engineering concentration
Power electronics concentration
Power systems concentration
Solid-state electronics concentration

Reliability and Maintainability Engineering
MS

Computer engineering concentration
Electrical engineering concentration

The Department of Electrical and Computer Engineering offers graduate programs leading to the Master of Science and Doctor of Philosophy with a major in electrical engineering or computer engineering.
The departmental graduate committee is responsible for administering, promoting, and advancing the general well being of the graduate program. Departmental actions regarding a graduate student may be appealed in writing, first to the departmental graduate committee and then to the department faculty.

The requirements outlined below apply to graduate degrees in both electrical engineering and computer engineering. The research project emphasis and/or the specific courses taken will determine the actual degree awarded.

**MASTER OF SCIENCE**

**COMPUTER ENGINEERING MAJOR**

Graduate work leading to the Master of Science with a major in electrical engineering or computer engineering may be completed during three semesters of full-time study or two to three years of part-time study.

**Admission**

Applicants for admission to the MS program are expected to have completed a bachelor’s degree in electrical engineering or computer engineering with an average of at least 3.00 out of 4.00, both overall and in the senior year. In addition, all applicants are required to submit scores from the general Graduate Record Examination (GRE). Applicants whose native language is not English, including those who have earned degrees at U.S. institutions, must score at least 213 on the computer-based TOEFL exam, 550 on the written exam, or 80 on the Internet-based Test to be considered for admission to the program.

Applicants who hold the bachelor’s degree in other fields of engineering, computer science, mathematics, or the physical sciences are also expected to have a minimum cumulative grade-point average of 3.00 and a minimum senior year average of 3.00 in that field. The department will require that selected undergraduate courses be taken as determined by the applicant’s prior education and experience. The student will be admitted under non-degree status until the required undergraduate courses are successfully completed with a 3.00 average.

**Requirements**

Students may choose between a thesis option, a non-thesis course-only option, and a non-thesis project option MS program. All students must file a Master’s Program Plan with the departmental graduate committee specifying which option they have selected, a semester-by-semester schedule of the courses they intend to take, and the members of the student’s master’s committee. Students may change between options one time by filing an amended Master’s Program Plan and with approval of the departmental graduate committee. A student who receives financial support under a research assistantship is enrolled in the thesis option by default. Students who have held a research assistantship will require approval from the departmental graduate committee to change to one of the non-thesis options. Candidates for the MS with a major in computer engineering are required to take at least two courses from the electrical and computer engineering 500-level series as part of their curriculum.

**Thesis Option (30 hours)**

- 6 semester hours of mathematics at the 400-level* or above, selected from a list approved by the graduate committee; or 6 semester hours of ECE courses at the 500 level or above; or 6 semester hours of non-ECE courses approved by the student’s master committee and the graduate committee.
- An additional 18 semester hours of 400-level* or above work in electrical and computer engineering, with at least 6 hours of 500-level or 600-level work in each of two areas of electrical and computer engineering.
- Master’s thesis, totaling 6 hours.
- A final oral examination covering the thesis and related coursework.

**Non-Thesis Courses Only Option (30 hours)**

- 6 semester hours of mathematics at the 400-level* or above, selected from a list approved by the graduate committee; or 6 semester hours of ECE courses at the 500 level or above; or 6 semester hours of non-ECE courses approved by the student’s master committee and the graduate committee.
- An additional 24 semester hours of 400-level* or above work in electrical engineering or computer engineering with 18 of the hours at the 500-level or 600-level. Of the 18 hours required at the graduate level, at least 6 must be in each of two areas of electrical engineering or computer engineering and an additional 6 hours outside of the two areas.
- A final comprehensive written examination. This examination will be given in January and August.

**Non-Thesis Project Option (30 hours)**

- 6 semester hours of mathematics at the 400-level* or above, selected from a list approved by the graduate committee; or 6 semester hours of ECE courses at the 500 level or above; or 6 semester hours of non-ECE courses approved by the student’s master committee and the graduate committee.
- An additional 21 semester hours of 400-level* or above work in electrical engineering or computer engineering, with 15 of the hours at the 500-level or 600-level. Of the 15 hours required at the graduate level, at least 6 must be in each of two areas of electrical engineering or computer engineering and an additional 3 hours of work outside of the two areas.
- ECE 501 (Project in Lieu of Thesis) with a minimum grade of B. This course will be administered by the student’s master committee. A written project proposal describing what the student will do in the course must be submitted in advance for the graduate committee’s approval. A written final report and oral presentation is required and one copy of the final draft must be submitted to the graduate committee.
- A final written and oral examination covering the project and related coursework.

**DUAL MS-MBA**

**Computer Engineering Major • Electrical Engineering Major**

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<td><strong>Total 60</strong></td>
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</table>

*NOTE: At least two thirds of the minimum required hours must be taken in courses numbered at or above the 500 level.*
DOCTOR OF PHILOSOPHY
COMPUESTA ENGINEERING MAJOR
ELECTRICAL ENGINEERING MAJOR

The PhD is offered with a major in computer engineering or electrical engineering. Exceptional students holding the bachelor’s degree may be admitted to the doctoral program without first obtaining a master’s degree. Candidates holding the MS must satisfy requirements 2 through 7 below while candidates holding only the BS must satisfy requirements 1 through 7.

Applicants are required to submit scores from the general Graduate Record Examination (GRE). A TOEFL score of 550 on the written exam, 213 on the computer exam, or 80 on the Internet-based Test is required for non-native speakers of English, including those who have earned degrees at U.S. institutions. Specific departmental requirements for the PhD include the following.

1. For students holding only a BS, a minimum of 48 course hours is required. Exceptional PhD students may request that course hour requirements of 48 hours beyond the BS degree be reduced to a lesser number, but not less than 39 hours beyond the BS. Request for this reduction is to be initiated by the student's PhD dissertation committee. The student’s major professor, with the concurrence of the dissertation committee, will prepare a curriculum plan showing exactly what courses will be taken and provide a justification as to why a reduced course hour requirement is appropriate. The request will be submitted to the Graduate Committee for approval. The Graduate Committee may approve/deny or modify the requested reduction. Any reduction in course hours granted will be contingent upon successful completion of all other PhD requirements under the supervision of the major professor and dissertation committee in place at the time of the request for reduction in course hour requirements. An approved reduction in course hour requirement will be automatically rescinded, unless reinstated by the Graduate Committee, if the student makes a subsequent change in the dissertation committee. The minimum dissertation hours required of students receiving approval for reduced course hours (normally 24) will be increased by exactly the amount of the reduction in required course hours. The first 24 hours should satisfy
   a. 6 semester hours of mathematics at the 400-level* or above, selected from a list approved by the graduate committee; or 6 semester hours of ECE courses at the 500 level or above; or 6 semester hours of non-ECE courses approved by the student’s master committee and the graduate committee.
   b. An additional 18 semester hours of 400-level* or above work in electrical and computer engineering, with at least 6 hours of 500-level or 600-level work in each of two areas of electrical and computer engineering.

   In addition, the student must satisfy requirements 2 through 7 below.

2. For students holding an MS, a minimum of 24 semester hours of coursework, excluding research and dissertation credit or seminar courses, must be taken at the University of Tennessee, Knoxville. These hours must include the following.
   a. A minimum of 12 semester hours in electrical and computer engineering at the 500 and 600 levels.
   b. A minimum of 9 semester hours of 600-level coursework. At least 3 hours of this work must be in an area other than the student’s major area.
   c. A minimum of 6 hours of mathematics at the 500-level or above and approved by the departmental graduate committee.

3. Satisfactory performance on a qualifying examination. Separate qualifying examinations are offered for electrical engineering and for computer engineering. The qualifying examination is prepared by the electrical and computer engineering faculty and consists of two 4-hour written examinations covering courses required in the undergraduate electrical and computer engineering curriculum through the junior level. The qualifying examination is offered twice each year (January and August), and a student is to take it the first time it is offered after the student enrolls in the program. A student who fails the qualifying examination must take and pass the examination the next time it is offered to remain in the program. A minimum of 12 hours of coursework must be completed after the student has taken the qualifying examination the first time.

4. Satisfactory performance on a comprehensive examination administered by the student's committee. The exam results are reported to the graduate committee for approval and the exam is filed in the department. The comprehensive exam is given when the student is ready to apply for admission to candidacy. The comprehensive examination consists of both written and oral parts. The written part consists of a complete review of the literature in the student’s dissertation topic and a review of the major tools to be used in the dissertation work. The student’s committee may require additional written sections. The student must demonstrate a mastery of the dissertation area, ability to think analytically and creatively, skill in using academic resources, and ability to complete the dissertation satisfactorily. The oral part of the comprehensive examination consists primarily of a professional presentation of a proposal for dissertation work and its defense. The committee may cover additional topics in the oral part.

5. Participation in departmental seminars.


7. Successful public defense of the dissertation by the student.

*NOTE: At least two thirds of the minimum required hours must be taken in courses numbered at or above the 500 level.

DEPARTMENT OF INDUSTRIAL
AND INFORMATION
ENGINEERING

http://www.engr.utk.edu/ie/

Alberto Garcia, Interim Head
Rudy Sawhney, Graduate Liaison

Professors
Ding, F., PhD .......................... North Carolina State
Garcia, A. (Associate Dean),
PhD ................................ University of Illinois at Urbana-Champaign
Garrison, G.W. (UTSI), PhD .......................... North Carolina State
Kuo, W. (Dean and University Distinguished Professor), PhD .......................... Kansas State

Associate Professors
Aikens III, C.H., PhD .......................... Tennessee
Jackson, D.F., PhD, PE .......................... Tennessee
Sawhney, R.S., PhD .......................... Tennessee

Assistant Professors
Ford, R.E., PhD .......................... Tennessee
Jeong, M.K., PhD .......................... Georgia Tech
Kim, D., PhD .......................... Florida
Kong, D., PhD .......................... Penn State
Li, X., PhD .......................... Arizona State

Research Faculty and Staff
Halstead, P.D., BS .......................... State University of New York
The Departmental Graduate Committee is responsible for administering, promoting, and advancing the general well being of the graduate program. Departmental actions regarding a graduate student may be appealed in writing, first to the departmental graduate committee and then to the departmental faculty.

Admission
Applicants must first submit a formal Graduate Application for Admission. In addition to the minimum requirements of the Graduate Council, the Department of Industrial and Information Engineering requires

- Three rating forms or letters of reference.
- GRE scores.
- Essay (two double-spaced pages – contact department for current topic).

The Departmental Graduate Committee sets any prerequisite courses or other measures that apply to the particular situation of the applicant. The department and the Office of Graduate and International Admissions must be notified of any change in the entering date after admission has been granted.

MASTER OF SCIENCE

INDUSTRIAL ENGINEERING MAJOR

Students who enroll in the Master of Science program may select a concentration in engineering management, human factors engineering, manufacturing systems engineering, product development and manufacturing or traditional industrial engineering. Each of these concentrations, with the exception of the product development and manufacturing, allows a student to select either a thesis or non-thesis option. Students who select the manufacturing systems engineering concentration of the dual degree program must select the non-thesis option. The thesis option requires 27 hours of coursework and 6 hours thesis. The non-thesis option requires 30 hours of coursework and a 3-hour design project. The engineering management concentration requires an additional 3 hours.

INDUSTRIAL ENGINEERING CONCENTRATION

Depending upon a student’s background and career objectives, graduate work in industrial engineering enables the student to select an area of specialization from operations research, human factors engineering, information systems engineering, maintenance and reliability engineering, or general industrial engineering.

INFORMATION ENGINEERING CONCENTRATION

Information engineering is concerned with the specification, design, implementation and management of data- and knowledge-intensive information systems. The engineering of large-scale information systems requires knowledge and practical experience in areas such as database management systems, data modeling, information optimization, knowledge acquisition, data/knowledge representation, software systems engineering, and network design and management.

ENGINEERING MANAGEMENT CONCENTRATION

The engineering management concentration has an additional admission requirement of two years relevant experience as a practicing engineer or scientist. This concentration is fully supported off-campus, utilizing electronic media for videotaping and interactive distance teaching methods.

HUMAN FACTORS ENGINEERING CONCENTRATION

Human factors engineering is concerned with ways of designing jobs, machines, operations, and work environments so they are compatible with human capacities and limitations. The human factors practitioner, operating within an industrial or service environment, is called upon both to apply existing human performance knowledge to the design or modification of work and workplaces and also to generate new experimental data required for system design and evaluation.

MANUFACTURING SYSTEMS ENGINEERING CONCENTRATION

Under the manufacturing systems engineering concentration, students learn strategies for improving product quality, implementing various production strategies, analysis of production planning and scheduling systems, and supplier and distribution integration. Dual degree students can select manufacturing systems engineering as an option.

PRODUCT DEVELOPMENT AND MANUFACTURING CONCENTRATION

The product development and manufacturing concentration is a non-thesis option, available only to students taking the dual MS-MBA program.

DUAL MS-MBA

Industrial Engineering Major • Manufacturing Systems Engineering • Product Development and Manufacturing Concentrations

<table>
<thead>
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<th>Hours Credit</th>
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<td>August – First Year</td>
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<td>Summer</td>
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<td>MBA Hub Course Elective</td>
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<td>Summer (first session)</td>
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<td>Total 60</td>
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DOCTOR OF PHILOSOPHY
INDUSTRIAL ENGINEERING MAJOR

Admission

Admission to the PhD program requires an undergraduate degree and academic background that meets the admission criteria for the master’s program in industrial engineering or a master’s degree in industrial engineering (or a closely related field), and previous academic performance that clearly demonstrates the capacity to do original research and technical investigative work and the potential for a successful scholarly career. If admitted, prerequisites (if required) will be established by the graduate committee based on the student’s academic background. All students are required to take the Graduate Record Examinations (GRE) and submit three letters of reference and a personal statement about their professional goals. International students are also required to take the Test of English as a Foreign Language (TOEFL).

Requirements

The total program of study requires a minimum of 72 graduate hours beyond the bachelor’s degree, exclusive of credit for the master’s thesis. This includes a minimum of 36 graduate hours of coursework beyond the bachelor’s degree and 24-36 hours of doctoral research and dissertation work. For a master’s program completed at another institution or in another field, the requirement may exceed the 36 hours of coursework (other than research and dissertation) dependent on the previous program of study.

GRADUATE CERTIFICATE IN
ENGINEERING MANAGEMENT

The Industrial and Information Engineering Department offers a graduate certificate in engineering management. The program is designed for professionals who work in an engineering organization and are interested in improving their technical management skills and knowledge. The program consists of four graduate courses that are available through distance education.

The 12-hour graduate certificate is earned by completing Engineering Management 533, 534, 536, and 539 with a grade of B or better. The hours may be utilized toward a graduate degree later if the student meets all other degree requirements.

Applicants must meet the minimum admission requirements and be admitted to the University of Tennessee, Knoxville, Graduate School. The only academic prerequisite for the certificate program is a bachelor’s degree from a recognized university or college.

DEPARTMENT OF MATERIALS
SCIENCE AND ENGINEERING

http://www.engr.utk.edu/mse/

George M. Pharr, Head

Professors

Benson, R.S., PhD ................................. Florida State
Bhat, G.S., PhD ................................. Georgia Tech
Bresee, R.R., PhD ................................. Florida State
Dahotre, N.B., PhD .............................. Michigan State
Egami, T., PhD ................................. Pennsylvania
George, E.P., PhD ............................... Pennsylvania
Joy, D.C., DPhil ................................. Oxford (UK)
Liaw, P.K., PhD ................................. Northwestern
Liu, C.T., PhD ................................. Brown
Lundin, C.D., PhD ............................... Rensselaer Polytechnic Institute
McHargue, C.J., PhD ............................ Kentucky
Nieh, T.G., PhD ................................. Stanford
Pharr, G.M., PhD, PE .......................... Stanford
Simpson, M.L., PhD ............................ Tennessee
Spruiell, J.E., PhD .............................. Tennessee
Wadsworth, J., DEng .......................... Sheffield (UK)
Wadsworth, L.C., PhD ........................ North Carolina State

Associate Professors

Kit, K., PhD ................................. Delaware
Meek, T.T., PhD ............................... Ohio State
Morris, J.R., PhD ............................... Cornell
Rack, P.D., PhD ................................. Florida

Assistant Professors

Choo, H., PhD ................................. Illinois Institute of Technology
Gao, Y., PhD ................................. Princeton
Hu, B., PhD ................................. Chinese Academy of Sciences
Keppens, V., PhD .......................... Katholieke Universiteit Leuven (Belgium)
Rawn, C.J., PhD ................................. Arizona

Emeriti Faculty

Brooks, C.R., PhD ............................... Tennessee
Fellers, J.F., PhD ................................. Akron
Hansen, M.G., PhD .............................. Wisconsin

MAJORS

DEGREES

Materials Science and Engineering

MS, PhD

- Materials concentration
- Metallurgy concentration
- Nanomaterials concentration
- Polymers concentration
- Textiles concentration

Materials Science and Engineering

MS-MBA

Polymer Engineering

MS, PhD

- Polymer processing concentration
- Polymer science concentration
- Textile science concentration

Graduate programs are offered leading to the degrees of Master of Science and Doctor of Philosophy with a major in materials science and engineering or polymer engineering. Both the materials science and engineering and polymer engineering programs are flexible and interdisciplinary in nature. Students may be admitted from a wide range of disciplines. These include physics, chemistry, chemical engineering, mechanical engineering, electrical engineering, materials engineering, and engineering science programs.

The materials science and engineering concentrations offer specializations to include, but not limited to, ceramics, composites, electronic materials, physical metallurgy, materials processing, welding metallurgy and materials joining, corrosion science and engineering, biomedical materials, nonwovens science and technology, mechanical and physical behaviors of materials, and nanoscience and technology.

The polymer engineering concentrations offer specialty areas in rheology; polymer morphology; mechanical, physical, and chemical behaviors of polymers; composite materials; and nonwovens science and technology.

Admission

Applicants for admission to the MS and PhD programs in materials science and engineering and polymer engineering are expected to have completed a bachelor’s degree in an area of engineering or science with a grade-point-average of at least 3.00 out of 4.00 both overall and in the senior year. In addition, all applicants must submit scores from the general Graduate Record Examination (GRE). Applicants whose native language is not English must score at least 213 on the computer-based TOEFL examination, 550 on the written examination, or 80 on the Internet-based Test to be considered for admission to the programs.
MASTER OF SCIENCE
MATERIALS SCIENCE AND ENGINEERING
MAJOR

POLYMER ENGINEERING MAJOR

Thesis Option
A total of 30 hours is required for the MS with a major in either materials science and engineering or polymer engineering. Additional requirements include the following.

- A major consisting of 12 hours of graduate courses in materials science and engineering or polymer engineering. The materials science and engineering major must include 511, 512, 515, and 516 for the metallurgy concentration; 511, 512, 540, and 541 for the polymers concentration; 511, 512, 540, 552, and 553 for the textiles concentration; 511, 512, and two graduate specialization courses approved by the student’s faculty committee for the materials concentration; and 511, 512 and two courses from the approved nanomaterials specialization list for the nanomaterials concentration.

- Additional courses up to 12 hours total in related areas.
- Master’s thesis 500, totaling 6 to 12 hours.
- Satisfactory performance on a comprehensive oral examination administered by the faculty committee.

All resident students are required to participate in the graduate seminar in materials science and engineering or polymer engineering, as appropriate, during each semester in which it is offered. Three hours of Materials Science and Engineering 503 or 504 may be counted toward degree requirements. The materials science and engineering major must include 540, 541, 543, 546, 549, and 550 for the polymer processing and polymer science concentrations; and 540, 541 or 543, 549, 550, 552, and 553 for the textile science concentration; exceptions are given if similar material has been covered in prior coursework.

Non-Thesis Option
Any candidate may apply for a non-thesis option. Upon acceptance, a supervisory committee of three will be appointed. At least two members of the committee will be from the faculty in the major area, either materials science and engineering or polymer engineering. The requirements for completion of the non-thesis option are as follows.

- Completion of a total of 30 hours of graduate coursework. At least 18 of those hours must be in the department and up to 12 hours may be in related areas. Three hours of Materials Science and Engineering 503 or 504 may be counted toward degree requirements. The materials science and engineering major and the polymer engineering major must include the same courses required for the thesis option. The faculty committee must approve the candidate’s degree program.
- Satisfactory completion of Materials Science and Engineering 580 (Critical Review) as a culminating experience. This course shall include a comprehensive examination administered by the faculty committee.

DUAL MS-MBA

Materials Science and Engineering Major

<table>
<thead>
<tr>
<th>Hours Credit</th>
<th>August – First Year</th>
<th>Business Administration 511 MBA Core I</th>
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<td>1Mechanical Engineering 506</td>
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<td>Business Administration 512 MBA Core II</td>
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DOCTOR OF PHILOSOPHY
MATERIALS SCIENCE AND ENGINEERING
MAJOR

POLYMER ENGINEERING MAJOR

After one year in residence and with the approval of the faculty, a student may proceed directly to the doctoral program without completion of a master’s degree.

Requirements
Departmental requirements for completion of the doctoral degree are as follows.

- Satisfactory performance on the applicable comprehensive examination.
- Active participation in graduate seminars conducted by the department.
- For students proceeding directly to the PhD from the baccalaureate degree, a minimum of 72 graduate hours is required. These hours must include 42 graduate course hours with at least 6 hours of 600-level courses and 30 hours of dissertation. Six hours of Materials Science and Engineering 503 or 504 may be counted toward degree requirements. At least 24 hours must be courses taught in the department. The materials science and engineering major and the polymer engineering major must include the courses required for the master’s program. For students in the nanomaterials concentration at least 12 hours of coursework must be from the approved nanomaterials specialization list. In addition, for students in the textile science concentration of the polymer engineering major, the courses must include 541 and 543.
- For students having a thesis-based master’s degree from UT in materials science and engineering or polymer engineering or a master’s degree from another university in materials science and engineering, polymer engineering, or metallurgical engineering, a minimum of 48 graduate hours is required. These hours must include 18 hours of graduate coursework with at least 6 hours of 600-level courses and 30 hours of dissertation. Three hours of Materials Science and Engineering 503 or 504 may be counted toward degree requirements. For students in the nanomaterials concentration at least 12 hours of coursework must be from the approved nanomaterials specialization list. At least 12 hours must be courses in the department.
DEPARTMENT OF MECHANICAL, AEROSPACE, AND BIOMEDICAL ENGINEERING
http://www.engr.utk.edu/mabe/  
William R. Hamel, Head  
Gary V. Smith, Graduate Liaison

**Professors**  
Antar, B.N., (UTSI), PhD ........................................ Texas  
Arimilli, R.V., PhD ........................................ Virginia Tech  
Baker, A.J., PhD, PE ........................................ New York  
Dareing, D.W., PhD, PE ......................................... Illinois  
Flandro, G.A. (UTSI), PhD ..................................... Cal Tech  
Frankel, J.I., PhD ............................................... Virginia Tech  
Hodgson, J., PhD, PE .......................................... Georgia Tech  
Jendrucko, R.J., PhD, PE ....................................... Virginia  
Keyhani, M., PhD ............................................. Ohio State  
Kihn, K.D., PhD ................................................... Stanford  
Komistek, R.D., PhD ........................................... Memphis  
Landes, J.D., PhD, PE .......................................... Lehigh  
Majdalani J.C. (UTSI), PhD ................................... Utah  
Parang, M. (Associate Dean), PhD, PE ................. Oklahoma  
Parsons, J.R., PhD, PE ......................................... North Carolina State  
Schulz, R.J. (UTSI), PhD ....................................... Tennessee  
Smith, G.V., PhD, PE ........................................... Penn State  
Soliman, O., PhD, PE ........................................... Tennessee  
Stehnoff, J.S. (UTSI), PhD .................................... Chicago  
Vakili, A. (UTSI), PhD .......................................... Tennessee  
Wasserman, J.F., PhD, PE ...................................... Cincinnati

**Associate Professors**  
Boulet, J.A.M., PhD ........................................... Stanford  
Chellaboina, V.S., PhD ........................................ Georgia Tech  
Lin, C.X., PhD ..................................................... Chongqing (People’s Republic of China)  
Lyne, J.E., MD, PhD ............................................. North Carolina State  
Madhukar, M.S., PhD ........................................... Drexel  
Moulden, T.H. (UTSI), PhD ................................... Tennessee  
Nguyen, K., PhD ................................................ Colorado  
Pionke, C.D., PhD, PE .......................................... Georgia Tech

**Assistant Professors**  
DeSimidt, H.A., PhD ........................................... Penn State  
English, A., PhD ............................................... Harvard-MIT  
Karpov, E.G., PhD ............................................. Southampton (UK)  
Lee, D., PhD ...................................................... Minnesota  
Mahfouz, M.R., PhD ............................................ Colorado School of Mines

**Emeriti Faculty**  
Carley, T.G., PhD, PE .......................................... Illinois  
Forrester, J.H., PhD, PE ....................................... Iowa State  
Hodgson, J., PhD, PE ........................................... Georgia Tech  
Johnson, W.S., PhD, PE ....................................... Clemson  
Mattheo, A., PhD, PE .......................................... Illinois  
Milligan, M.W., PhD, PE ....................................... Tennessee  
Shannon, T.E., PhD, PE ...................................... Tennessee  
Snyder, W.T., PhD ............................................... Northwestern

**MAJORS**

**Aerospace Engineering**

- Aeroacoustics concentration  
- Aerodynamics and performance concentration  
- Energy conversion and utilization concentration  
- Flight and aerospace mechanics concentration  
- Gas dynamics concentration  
- Heat transfer and fluid mechanics concentration

**Biomedical Engineering**

- Applied artificial intelligence concentration  
- Biomedical engineering concentration  
- Computational mechanics concentration  
- Fluid mechanics concentration  
- Mechanics of composite materials concentration  
- Optical engineering concentration (UTSI only)  
- Solid mechanics concentration

**Mechanical Engineering**

- Dynamics, control, and robotics concentration  
- Energy conversion and utilization concentration  
- Gas dynamics concentration  
- Heat transfer and fluid mechanics concentration  
- Machine design concentration  
- Power generation concentration  
- Product development and manufacturing concentration  
- Propulsion concentration  
- Space engineering concentration  
- Stress analysis concentration  
- Thermodynamics concentration

**Mechanical Engineering**

- Aerospace engineering concentration  
- Biomedical engineering concentration  
- Mechanical engineering concentration

**Graduate Certificate Program**

- Computational fluid mechanics

- Graduate programs leading to the Master of Science and Doctor of Philosophy are available with majors in mechanical engineering, aerospace engineering, biomedical engineering, and engineering science. Changing from one of these programs to another requires departmental approval. Each applicant is advised as to any prerequisite courses before entering a program. A dual MS-MBA program with a concentration in product development and manufacturing is also available with a major in mechanical engineering or in engineering science.

- Within the engineering science concentrations interdisciplinary programs are arranged to meet individual needs or interests. The flexibility and interdisciplinary aspect of the program
concentrations are intended to be of particular interest to prospective students currently employed in research, development, or design activities and whose interests in continuing education (either full-time or part-time) lie at one of the interfaces between science and engineering or can best be met by interdisciplinary study in engineering. The program's course offerings and research activities are also intended to meet the needs of students who seek preparation for employment in engineering areas requiring specialization in mechanics or in related interdisciplinary studies such as bio-mechanics.

In mechanical engineering or aerospace engineering, entrance into the Master of Science program is available to qualified graduates of recognized undergraduate curricula in mechanical or aerospace engineering and to qualified graduates of other curricula who satisfy the necessary prerequisites. A program application is required in addition to the Graduate Application for Admission. Admission into the doctoral program will be granted to those applicants who have demonstrated superior achievement in their engineering backgrounds. The general GRE is required of all applicants for admission.

In biomedical engineering, entrance into the graduate program is available to graduates of recognized curricula in engineering, mathematics, or one of the physical sciences who satisfy the necessary prerequisites. A program application is required in addition to the Graduate Application for Admission. The names and addresses of three references must be included with the program application. The general GRE is required of all applicants for admission.

In engineering science, entrance into the graduate program is available to graduates of recognized curricula in engineering, mathematics, or one of the physical or biological sciences. A program application is required in addition to the Graduate Application for Admission. The names and addresses of four references must be included with the program application. The general GRE is required of all applicants for admission.

Each student must satisfactorily complete a program of study that has been approved by his/her advisory committee and complies with the requirements of the Graduate Council. In engineering science, the student's major professor may be selected from a department other than the Department of Mechanical, Aerospace, and Biomedical Engineering; however, at least one member of the student's graduate advisory committee must be on the faculty of the Department of Mechanical, Aerospace, and Biomedical Engineering.

### Graduate Credit for Undergraduate Courses

Students majoring in mechanical engineering or aerospace engineering may not normally use more than one 400-level engineering course to meet their advanced degree requirements. Undergraduate courses that are required for the bachelor's degree in mechanical engineering may not be taken for graduate credit by graduate students in mechanical engineering. Undergraduate courses that are required for the bachelor's degree in aerospace engineering may not be taken for graduate credit by graduate students in aerospace engineering. For students majoring in engineering science, 400-level graduate courses in engineering may be used to meet requirements at the discretion of the advising committee. However, at least two-thirds of the minimum required hours in a master's degree program must be at or above the 500-level. With the approval of the student's major department, a student whose major is outside the Department of Mechanical, Aerospace, and Biomedical Engineering may take 400-level graduate courses in the department. Such students should consult with instructors regarding prerequisites for undergraduate courses.

### MASTER OF SCIENCE

#### AEROSPACE ENGINEERING MAJOR

**BIOMEDICAL ENGINEERING MAJOR**

**ENGINEERING SCIENCE MAJOR**

**MECHANICAL ENGINEERING MAJOR**

### Requirements

In aerospace engineering, mechanical engineering, biomedical engineering, and engineering science, two MS options are offered. Option I requires a thesis and is the normal program for graduate students. Option II does not require a thesis and provides graduate students, including co-op and off-campus students, the opportunity to focus their programs in special areas through extended coursework.

#### Aerospace Engineering Major • Mechanical Engineering Major • Option I (Thesis)

<table>
<thead>
<tr>
<th>Hours Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Coursework total ........................................ 24</td>
</tr>
<tr>
<td>Thesis .................................................... 6</td>
</tr>
<tr>
<td><strong>Total 30</strong></td>
</tr>
</tbody>
</table>

1 Courses in program (500-level or above) – 12 hours minimum. Mathematics (400-level or above) – 6 hours minimum.

#### Aerospace Engineering Major • Option II (Non-Thesis)

<table>
<thead>
<tr>
<th>Hours Credit</th>
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</thead>
<tbody>
<tr>
<td>1Coursework total ........................................ 24</td>
</tr>
<tr>
<td>590 Selected Engineering Problems ........................ 6</td>
</tr>
<tr>
<td><strong>Total 30</strong></td>
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</table>

1 Courses in program (500-level or above) – 18 hours minimum. Mathematics (400-level or above) – 6 hours minimum.

#### Biomedical Engineering Major • Option I (Thesis)

<table>
<thead>
<tr>
<th>Hours Credit</th>
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<tbody>
<tr>
<td>1Coursework total ........................................ 24</td>
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<tr>
<td>Thesis .................................................... 6</td>
</tr>
<tr>
<td><strong>Total 30</strong></td>
</tr>
</tbody>
</table>

1 Engineering courses – 12 hours minimum. Mathematics (400-level or above) – 6 hours minimum. Related courses – 6 hours.

#### Biomedical Engineering Major • Option II (Non-Thesis)

<table>
<thead>
<tr>
<th>Hours Credit</th>
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<tbody>
<tr>
<td>1Coursework total ........................................ 24</td>
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<tr>
<td>2590 Selected Engineering Problems ......................... 6</td>
</tr>
<tr>
<td><strong>Total 30</strong></td>
</tr>
</tbody>
</table>

1 Engineering courses – 15 hours minimum. Mathematics (400-level or above) – 6 hours minimum.
2 May include additional courses in mathematics, computer science, or the physical and life sciences, as well as engineering courses.

#### Engineering Science Major • Option I (Thesis)

<table>
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<th>Hours Credit</th>
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<tr>
<td>1Coursework total ........................................ 24</td>
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<td><strong>Total 30</strong></td>
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</table>

1 Engineering courses – 12 hours minimum (major concentration may include, but is not restricted to, courses offered by the department). Mathematics (400-level or above) – 6 hours minimum. Related courses – 6 hours maximum (may include additional courses in mathematics, computer science, or the physical and life sciences).

#### Engineering Science Major • Option II (Non-Thesis)

<table>
<thead>
<tr>
<th>Hours Credit</th>
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<tr>
<td>1Coursework total ........................................ 24</td>
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</table>

1 Engineering courses – 12 hours minimum (major concentration may include, but is not restricted to, courses offered by the department). Mathematics (400-level or above) – 6 hours minimum. Related courses – 6 hours maximum (may include additional courses in mathematics, computer science, or the physical and life sciences).
For all program options, other 500-level engineering courses that are approved by the student’s master’s committee and the graduate programs committee may be substituted for the mathematics courses. All program options require participation in the departmental graduate seminars program and passing a final examination on all work submitted for the degree. The final examinations in Option II (non-thesis) will cover all coursework. The thesis option, Option I, requires submission and defense of a written thesis that demonstrates the ability to conduct and report an independent investigation.

**DUAL MS-MBA**

**Aerospace Engineering Major**

<table>
<thead>
<tr>
<th>Month – Year</th>
<th>Course Code</th>
<th>Hours Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>August – First Year</td>
<td>Business Administration 511 MBA Core I</td>
<td>3</td>
</tr>
<tr>
<td>Fall – First Year</td>
<td>Business Administration 512 MBA Core II</td>
<td>15</td>
</tr>
<tr>
<td>Spring</td>
<td>Mechanical Engineering 504</td>
<td>1</td>
</tr>
<tr>
<td>Summer</td>
<td>Business Administration 513 MBA Core III</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineering 506</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineering 508</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Internship</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Aerospace Engineering 509</td>
<td>1</td>
</tr>
<tr>
<td>Fall – Second Year</td>
<td>Aerospace Engineering 509</td>
<td>1</td>
</tr>
<tr>
<td>Spring</td>
<td>Departmental/Engineering Courses</td>
<td>9</td>
</tr>
<tr>
<td>Summer</td>
<td>MBA Hub Course Elective</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineering 509</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Departmental/Engineering Courses</td>
<td>9</td>
</tr>
<tr>
<td>Summer (first session)</td>
<td>Mechanical Engineering 594</td>
<td>3</td>
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**Total 60 Hours Credit**

**Biomedical Engineering Major**

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<tr>
<td></td>
<td>Internship</td>
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<tr>
<td>Fall – Second Year</td>
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**Mechanical Engineering Major**

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**Total 60 Hours Credit**

**Engineering Science Major**

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</tr>
<tr>
<td>Summer (first session)</td>
<td>Mechanical Engineering 594</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total 60 Hours Credit**

Dual degree candidates enrolled in engineering science are required to take 18 hours of graduate-level engineering courses during the second year of the program. This program requires a coursework plan, approved by the Dual Program Committee, including a concentration such that the student can accomplish his/her teamwork assignments.
DOCTOR OF PHILOSOPHY
AEROSPACE ENGINEERING MAJOR
BIOMEDICAL ENGINEERING MAJOR
ENGINEERING SCIENCE MAJOR
MECHANICAL ENGINEERING MAJOR
Requirements

All students must complete a minimum of 72 semester hours beyond the bachelor’s degree, exclusive of credit for the master’s thesis. These shall include a minimum of 24 hours in Doctoral Research and Dissertation and a minimum of 48 semester hours in other courses.

In mechanical engineering, aerospace engineering, or biomedical engineering, the courses must include the following.

- A minimum of 12 semester hours of graduate credit in mathematics courses numbered 400 or above with a minimum of 6 hours numbered 500 or above.
- A minimum of 24 semester hours in the department in courses numbered 500 and above, with at least 12 of these hours in the major. A minimum of 9 semester hours of courses is required at the 600 level. These are exclusive of thesis, problems, or dissertation credit. The student’s advisory committee can approve a student’s petition to replace one 600-level course with one or more 500-level course(s) that are more appropriate.

In engineering science, the courses must include the following.

- A minimum of 24 semester hours in engineering graduate courses, exclusive of thesis and dissertation credit. These courses will normally be numbered 500 and above, with at least 9 semester hours of 600-level courses, which constitute one or two areas of concentration selected by the student. The number of courses in this group to be taken will depend on the program selected by the student and the approval of his/her advisory committee.
- A minimum of 12 semester hours in mathematics or computer science in courses numbered 400 and above, exclusive of a first course in ordinary differential equations.

Additional requirements for all students include the following.

- Registration and participation in the graduate seminar in the major program.
- Meet all departmental examination requirements, which include passing a written and oral comprehensive examination.
- Presentation of a dissertation proposal to the student’s advisory committee and approval of that proposal by that committee.
- Successful defense of the dissertation.

GRADUATE CERTIFICATE IN COMPUTATIONAL FLUID DYNAMICS

The College of Engineering offers a graduate certificate in computational fluid dynamics (CFD). The program is designed primarily for the part-time student interested in gaining dexterity in this subject by taking a course sequence through distance education. All coursework is permanently archived at the College of Engineering Computational Fluid Dynamics Laboratory Web site, hence available on demand on a totally flexible schedule.

The 12-hour certificate is earned by completing the three courses, Engineering Science 551, 552, and 581 (CFD Laboratory), which are extensively cross-listed among departments in the College of Engineering. The certificate is completed with one elective 3-hour course from an approved list. Those currently approved are Chemical Engineering 507 and Electrical and Computer Engineering 599 (Computer Fire Modeling). A wider selection of courses will be added when they become available.
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 MS must be taken in courses numbered 500 or above.

MASTER OF SCIENCE
NUCLEAR ENGINEERING MAJOR

A graduate program leading to the Master of Science degree is available to graduates of recognized undergraduate curricula as described above. Each applicant will be advised as to the necessary prerequisite courses before he/she enters the program.

Requirements

The minimum requirements for the MS in nuclear engineering are

- A major consisting of 12 hours of graduate courses in nuclear engineering which must include at least one of the following sequences — 511, 512; 521, 522; 551, 552; 571, 572; 581, 582.
- A minor consisting of 6 hours of elective courses in mathematics, statistics, or another field related to nuclear engineering.
- 6 hours in either nuclear engineering or a related field.
- One of the following four options for a culminating experience.

Option 1 – a thesis project (6 hours of 500).
Option 2 – two to four engineering practice projects (6 hours of 598).
Option 3 – one engineering practice project (3 hours of 598) plus 6 hours of additional nuclear engineering coursework.
Option 4 – nine hours of additional nuclear engineering coursework and a comprehensive written exam on all coursework prepared by the student’s graduate committee (i.e., no thesis or engineering practice project).

Options 1 and 2 result in a minimum total of 30 hours and Options 3 and 4 result in a minimum total of 33 hours. The determination of which option a student may undertake is made by the student’s graduate committee and is based on the student’s personal interests, academic background, and work experience, as well as the nature of projects currently available in the department.

A thesis project requires the student to conduct independent, in-depth research. An engineering practice project is similar to a thesis project but smaller in scope and can be research, design, product development, special operations, or a critical review of published literature in a specific technical area. The student must submit a brief written proposal for each project undertaken, either thesis or engineering practice, which must be approved by the student’s graduate committee. The final report for an engineering practice project is normally prepared in thesis format (i.e., according to the Graduate School, Guide to the Preparation of Theses and Dissertations); however, another formal report format may be used if approved by the student’s graduate committee. The student must also register for the appropriate number of hours of either 500 or 598, as specified by the student’s major professor, during each semester that work is performed on a thesis or engineering practice project. Finally, the student must pass an oral examination on all work presented for the degree (all coursework and all projects).

The MS with a major in nuclear engineering is also available to distance students via selected courses that are delivered synchronously over the Web to the student’s computer. More detailed information about this distance program is located at http://www.anywhere.tennessee.edu/ne/default.htm.

DUAL MS-MBA

The College of Business Administration and the College of Engineering offer an integrated program in product development and manufacturing leading to the conferral of the Master of Business Administration degree and the Master of Science degree with a major in nuclear engineering. The establishment of the dual program addresses the critical need for personnel trained in both engineering and management who can integrate an increasingly complex body of knowledge for rapid introduction of new products to the marketplace. The objective of the dual degree program is to prepare graduates to take a leading management role in companies that must react quickly to a dynamic market where forces of competition require rapid changes in design and manufacturing and a short product development cycle.

Admission

Applications are accepted for fall semester only. Applicants for the MS-MBA program must make separate application to, and be competitively and independently accepted by the Office of Graduate and International Admissions for the Master of Business Administration program and the Master of Science program with a major in nuclear engineering, and by the Dual Program Committee.

Students will initially apply for the MBA program, indicating on their application the intent to pursue the dual MS-MBA program and the appropriate engineering major (refer to the MBA program for separate instructions). Students accepted for both the MBA and the MS with a major in nuclear engineering will be assigned to a Dual Program Committee advisor (a faculty member in nuclear engineering) who will be responsible for course approval and overall supervision of the students’ progress through the dual program.

Applications by United States citizens and permanent residents received after the MBA application deadline (March 1) will be considered as space allows. Additional information is required and different application dates are established by the Office of Graduate and International Admissions for international students.

Requirements

All engineering students enrolled in the product development and manufacturing program must complete common coursework designed to provide them with an integrated, multidisciplinary teamwork experience. The MBA curriculum in product development and manufacturing consists of 33 hours of common coursework in the College of Business Administration and 15 hours of common coursework in the College of Engineering. Engineering common coursework includes a culminating 3-hour integrated project course requiring a comprehensive report, and a final examination as required by the Dual Program Committee, to be taken during the first session of summer following the second year.

During the second year, dual degree candidates will also take courses in their engineering major. The coursework is designed to provide students with a concentration in their major and advanced skills to accomplish their teamwork assignments. Dual degree candidates enrolled in nuclear engineering are required to take 18 hours of graduate-level nuclear engineering courses during the second year of the program, which must be approved by the student’s Dual Program Committee Advisor. In addition, a dual degree candidate who majors in nuclear engineering must successfully defend, in an oral examination administered by at least three nuclear engineering faculty members, and pass the student’s Dual Program Committee Advisor, all work presented for the MS degree (all coursework and the culminating integrated project).
Nuclear Engineering Major

August – First Year
Business Administration 511 MBA Core I ................................. 3

Fall – First Year
Business Administration 512 MBA Core II ................................. 15
Mechanical Engineering 504 Product Development Process ............. 1

Spring
Business Administration 513 MBA Core III ................................. 9
Mechanical Engineering 506 Product Selection and Evaluation .......... 2
Mechanical Engineering 508 Integrated Product, Process, and Manufacturing System Design ....................... 3

Summer
– Internship .................................................................................. –
Nuclear Engineering 509 Project Management ............................... 1

Fall – Second Year
Nuclear Engineering 509 Project Management ............................... 1
– Nuclear Engineering Courses .................................................. 9

Spring
– MBA Hub Course Elective ...................................................... 3
Nuclear Engineering 509 Project Management ............................... 1
– Nuclear Engineering Courses .................................................. 9

Summer (first session)
Nuclear Engineering 594 Culminating Integrated Project Report ....... 3

Total 60

The dual degree candidate must satisfy the curriculum and graduation requirements of the engineering major being pursued and the College of Business Administration. Students withdrawing from the dual degree program before completing both degrees will not receive credit toward graduation in either degree program for courses taken in the other degree program, except as such courses qualify for credit without regard to the dual degree program. The MS and the MBA will be awarded upon successful completion of the requirements of the dual program.

DOCTOR OF PHILOSOPHY
NUCLEAR ENGINEERING MAJOR

Students in the field of nuclear engineering desiring to study for the Doctor of Philosophy degree must have a Bachelor of Science or Master of Science from a recognized university with a major in engineering, physics, chemistry, or mathematics. All candidates will be required to demonstrate general competence in a comprehensive examination in the areas of engineering science, mathematics, chemistry, physics, and nuclear engineering.

Requirements

Specific requirements for the PhD with a major in nuclear engineering include the following:

• A minimum of 48 hours beyond the bachelor’s degree, exclusive of credit for the MS thesis or nuclear engineering practice.

• A minimum of 24 hours in doctoral research, Nuclear Engineering 600.

• A minimum of 30 hours in nuclear engineering courses numbered 500 and above (or the equivalent), with at least 9 hours of 600-level courses. These are exclusive of thesis or dissertation credit. Three of the 9 hours of 600-level courses can be from a department other than nuclear engineering, provided the selection supports the student’s research area.

• A minimum of 12 hours in mathematics, statistics or other courses related to nuclear engineering beyond nuclear engineering undergraduate requirements numbered 400 or above.

• A minimum of 6 hours in courses numbered 500 or above from a department other than nuclear engineering. The choice depends on the student’s overall program and should expand his/her knowledge in a given field.

The first part of the comprehensive examination is prepared by the nuclear engineering faculty and consists of 6 hours of written examination that is administered over a two-day period. All past written examinations are filed in the library and students are encouraged to review them. Students are invited to take the written examination after completing approximately 30 hours of graduate coursework. A student who fails the written examination must take and pass the examination the next time it is offered to remain in the PhD program. Registration for 600 is not permitted until the written examination is passed. The second part of the comprehensive examination is completed with the successful oral defense of a written dissertation proposal.

A candidate must successfully defend, in an oral examination, all work presented for the degree (all coursework and the dissertation).

GRADUATE CERTIFICATE IN NUCLEAR CRITICALITY SAFETY

The Department of Nuclear Engineering offers a graduate certificate in nuclear criticality safety. The program is designed primarily for part-time students. All of the courses are available through distance education (see http://www.anywhere.tennessee.edu/ne/default.htm).

The 12-hour certificate is earned by completing 421, 543, and 582 plus one of the following three courses: 470, 571, or 581. The selection of one of the latter three courses is determined through an advising conference with each individual student and is based on the student’s personal interests, academic background, and work experience. Applicants must meet the minimum criteria established by the Graduate Council. Students without a nuclear engineering background must take Nuclear Engineering 301 prior to beginning the graduate coursework described above.