College of Engineering

Dean's Office
UNT Research Park, H140
P.O. Box 310440
Denton, TX 76203-0440
(940) 565-4300

Main Campus Office (Advising)
Hickory Hall, 120
(940) 565-4201

Web site: *www.eng.unt.edu*

Oscar N. Garcia, Dean

Reza Mirshams, Associate Dean
Kathy Swigger, Associate Dean

Programs of Study

The College of Engineering, through its disciplines of science, engineering and technology, offers course work leading to the following degrees:

- Master of Science and
- Doctor of Philosophy, both with a major in computer science;
- Master of Science with a major in computer engineering;
- Master of Science with a major in electrical engineering;
- Master of Science with a major in engineering technology;
- Master of Science, and
- Doctor of Philosophy, both with a major in materials science and engineering.
- Master of Science with a major in mechanical and energy engineering;

Master's degrees are offered by all academic departments in the college.

Doctoral programs in the college typically reflect the areas of academic specialization or focus of the various departments (see individual departmental descriptions in this catalog for specific information). All areas offer challenging programs that provide students with the opportunity to become experts in their chosen fields. A major emphasis in the college is to train graduate students in the fundamentals of engineering and scientific research and to prepare them, especially on the doctoral level, to be critical thinkers who can advance human knowledge through research.

The college is composed of the following five academic departments.

- Computer Science and Engineering

- Electrical Engineering
- Engineering Technology
- Materials Science and Engineering
- Mechanical and Energy Engineering

Research

Research interests in the Department of Computer Science and Engineering include theoretical computer science, databases, visualization, game programming, wired and wireless networks, computer security, artificial intelligence, natural language processing, computer systems architecture, agent-based systems, collaborative learning, parallel and distributed processing, and numerical analysis.

The research areas in the Department of Electrical Engineering include signal processing, wireless communication, channel modeling and measurement, radar systems, VLSI design and testing, analog and mixed-signal IC design, nano-scale semiconductor device modeling and design, wireless sensor network design, radio-frequency identification (RFID) systems, sensor and sensor interface design, coding theory, bioinformatics, artificial intelligence, pattern recognition and multisensor fusion.

Research capabilities in the Department of Engineering Technology include small target visibility, noise cancellation, VLSI design of antenna array, logic circuit design, applications of technology to education, biomedical optics, pulse oximetry, telemedicine, liquid nitrogen automobiles, mechanical behavior of materials for structures and micromechanical systems, control systems, field emissions and corrosion engineering.

Research programs in the Department of Materials Science and Engineering emphasize hands-on research with modern equipment and facilities. Areas of research include polymers, nanocomposites, electronic materials and molecular electronics.

Research programs in the Department of Mechanical and Energy Engineering emphasize the fundamentals of energy production, management and distribution. Areas of research include advanced thermomechanical conversion; computational fluid dynamics and heat transfer; multiphase flow, mass transfer and combustion; heating, ventilation and air-conditioning; and advanced thermal manufacturing methods with lasers.

Advising

For general information, contact the Toulouse School of Graduate Studies. For specific requirements for graduate degrees, contact the appropriate department chair or graduate adviser.

Department of Computer Science and Engineering

Main Departmental Office
UNT Research Park, F201
P.O. Box 311366
Denton, TX 76203-1366
(940) 565-2767

Web site: *www.cse.unt.edu*

Krishna M. Kavi, Chair

Graduate Faculty: Akl, Brazile, Buckles, Dantu, Huang, Irby, Jacob, Kavi, Keathly, Li, Mihalcea, Mikler, Mohanty, Oh, Parberry, Renka, Shahrokhi, Sweany, Swigger, Tarau, Tate, Yuan.

The Department of Computer Science and Engineering offers graduate programs leading to the following degrees:

- Master of Science with a major in computer engineering;
- Master of Science, and
- Doctor of Philosophy, both with a major in computer science.

Information regarding these degree programs, including admission requirements and degree requirements, can be obtained from the department's web site.

The objective of the master's degree is to produce professional computer scientists capable of contributing technically to the basic core areas of computer science and computer engineering as well as to application areas. The objective of the doctoral degree is to produce professionals capable of conducting and directing research within the discipline of computer science.

The department is committed to overall excellence in graduate education. Consequently, the programs of study for these degrees include a mixture of course, laboratory and research work designed to place graduates at the forefront of technical excellence.

The department also supports an interdisciplinary doctorate with a major in information science. See the School of Library and Information Sciences section of this catalog for more information.

Research

The Department of Computer Science and Engineering has a comprehensive research program. Current faculty research interests include theoretical computer science, databases, game programming,

wired and wireless networks, computer security, artificial intelligence, natural language processing, computer systems architecture, agent-based systems, collaborative learning, parallel and distributed processing, numerical analyses, wireless communication, image understanding, sensor fusion, data mining, evolutionary computation, computational epidemiology, VLSI design, medical imaging, compilers, algorithm analyses, human factors, cryptography, image processing, and bioinformatics.

The **Network Security Laboratory** was established to increase general wireline and wireless security awareness of computer science and engineering graduates, to produce skilled security specialists, and to conduct research and development activities to advance the state-of-the-art in wireline and wireless security and communication.

The **Computer Privacy and Security Laboratory** (CoPS) conducts research on improving privacy and security of computer systems.

The **Computer Systems Research Laboratory** investigates multithreaded architectures, compiler optimizations, memory systems, intelligent memory devices and real-time and embedded processing. The resources available to this research include Compaq (DEC) Alpha Servers, Sun Workstations, a four-node SUN SMP server, a tera-byte storage system and several PC-based Linux and Windows systems.

Intelligent Distributed Software Systems provides the software and hardware infrastructure for research and graduate teaching in new and exciting areas such as intelligent mobile agents, distributed artificial intelligence and Internet programming.

The **Laboratory for Recreational Computing** (LARC) serves as a center for research, education and development in the field of computer game programming.

The **Geometric Computing Laboratory** conducts research to improve the effectiveness and efficiency of geometric algorithms.

The **Language and Information Technologies Laboratory** researches various aspects of natural language processing and computational linguistics, including text understanding, machine translation, information retrieval and speech technologies.

The **Network Research Laboratory** conducts research in high-speed networking techniques and applications.

The **VLSI Design and CAD Laboratory** (VDCL) carries out research in low-power design and CAD for nano-scale VLSI circuits.

The **Computational Epidemiology Research Laboratory** (CERL) applies computational science paradigms to the domain of public health, thereby providing tools for epidemiologists and public health researchers.

The **Wireless Sensor Laboratory** (WiSL) was established with the following mission: to increase general wireless communications awareness among computer science and engineering graduates, produce skilled wireless specialists, and conduct research and development activities to advance the state-of-the-art in wireless sensors.

Net Centric Systems. The UNT CSE department is a member of the Net Centric Software Consortium which includes faculty from UTA, UTD and SMU. The consortium members conduct research and development in Net Centric Systems. Net-centricity is an emerging paradigm and family of techniques, procedures and capabilities that utilize a networked environment to meet new and evolving challenges through information integration and adaptive solutions.

Faculty research has been supported through grants from federal and state institutions and private industry including the National Science Foundation, Texas Department of Transportation, Texas Higher Education Coordinating Board, Oak Ridge National Laboratory, Google and Microsoft. The department enjoys a friendly working relationship with local and national companies. The department's Advisory Council is composed of representatives from government agencies and high-tech firms. During the past few years they have helped obtain research funding, fellowships and internships for students in the department.

Degree Programs

The department offers graduate programs leading to the following degrees:

- Master of Science with a major in computer engineering;
- Master of Science, and
- Doctor of Philosophy, both with a major in computer science.

Information regarding these degree programs, including admission requirements and degree requirements, can be obtained from the department's web site.

Admission to graduate degree programs in computer science and computer engineering is competitive. Applications, complete with transcripts, GRE scores (UNT computer science and engineering graduates are exempt.) and TOEFL scores, must reach the computer science and engineering department by the following dates to be considered for the term/semester indicated.

October 1 — spring term/semester
March 1 — summer term
March 1 — fall term/semester

Note that fall applications must be received by March 1 in order to be considered for an assistantship. Students must submit a completed application for assistantship by the above deadline to be considered for financial assistance. Applications are available on the department's web site.

Computer Engineering Program

Master of Science

The department offers the Master of Science with a major in computer engineering.

Program Objectives

1. Graduates will exhibit skills needed to pursue doctoral-level work as well as research careers in industry and academia.

2. Graduates will possess a strong background in the breadth of computer engineering, as evidenced by a good balance between software and hardware skills, including software development, design of digital systems, microprocessors, embedded systems, real-time systems and digital communication networks.

3. Graduates will demonstrate a strong, in-depth knowledge in one of the department's specialty areas: VLSI, real-time systems, computer systems and communication networks.

4. Graduates will exhibit excellent communication skills, both oral and written, that will assist them in achieving their career goals.

5. Graduates will be highly recruited in a competitive market and make valuable contributions to a wide variety of industries, particularly in computer and information technology.

6. Graduates will pursue life-long learning and continued professional development.

7. Graduates will demonstrate high levels of professional responsibility and ethical behavior.

8. Graduates will undertake leadership roles in their profession, in their communities and in the global society.

Admission Requirements

Admission requirements for the MS with a major in computer engineering will be the same as the requirements for the MS with a major in computer science (see below).

Admission to Candidacy

After removal of all deficiencies and upon completion of all the leveling courses (as described below), the student is required to submit a formal degree plan to his or her adviser and the Dean of the School of Graduate Studies. Failure to fulfill this requirement may prevent the student from enrolling the following term/semester. Admission to candidacy is granted by the Dean of the School of Graduate Studies after the degree plan has been approved.

Leveling Courses

- Mathematics through multivariable calculus
- Physics including mechanics, electricity and magnetism
- CSCE 2050, Computer Science III
- CSCE 3600, Principles of Systems Programming
- CSCE 3610, Machine Structures
- CSCE 3730, Reconfigurable Logic
- EENG 3510, Electronics I

All entering students must demonstrate knowledge of the material covered in these courses. An entering student may demonstrate knowledge of the material by:

- Completing the courses at UNT
- Completing similar courses at another institution
- Evidence based on employment experience

A student may be required to successfully pass a placement exam to demonstrate their knowledge of the material.

Degree Requirements

Option A: Thesis Option (31 hours that include CSCE 5020 and 6 hours of thesis). Leveling courses cannot be counted.

Option B: Course Option (37 hours that include CSCE 5020 and may include 3 hours of project or 6 hours of problem in lieu of thesis). Leveling courses cannot be counted.

Course Selection

- Leveling course(s) are required if applicant does not have a BS with a major in computer engineering.
- Select one core course from three of the four specialty areas.
- Select at least three courses from one area; at least one of these should be a 6000-level course.
- No more than 3 hours in non-organized class (such as individual study).
- As an introduction to the department, and to research and computer engineering in general, every master's-level student must take CSCE 5020, Current Research in Computer Science and Engineering, during the first long term/semester enrolled in graduate classes. One hour of credit is obtained from this course.
- The project requires enrollment in CSCE 5900, which requires a poster presentation of the project work at an open department reception. A final project report must be submitted to the graduate coordinator at least two weeks before the end of the student's final term/semester.

Academic Standards

If a student's GPA on all graduate and/or deficiency courses falls below 3.0, the student will be placed on probation the following term/semester. Students who cannot raise their GPA above 3.0 during that term/semester will be dropped from the program. To qualify for the master's degree, the student must earn a grade of B or better in each of the core courses.

Course Requirements

Area 1: VLSI

- CSCE 5730, Digital CMOS VLSI Design (core course)
- CSCE 5750, VLSI Testing
- CSCE 5760, Design for Fault Tolerance
- CSCE 6610, Advanced Computer Architecture
- CSCE 6730, Advanced VLSI Systems

Area 2: Communication and Networks

- CSCE 5510, Wireless Communications (core course)
- CSCE 5520, Wireless Networks and Protocols
- CSCE 5530, Computer Network Design
- CSCE 5540, Introduction to Sensor Networks
- CSCE 5570, Digital Communications
- CSCE 5580, Computer Networks (core course)
- CSCE 6581, Advanced Computer Networks
- CSCE 6590, Advanced Topics in Wireless Communications and Networks

Area 3: Real-Time Systems

- CSCE 5440, Real-Time Software Development
- CSCE 5620, Real-Time Operating Systems
- CSCE 5640, Operating System Design (core course)
- CSCE 6620, Advanced Real-Time Operating Systems
- ELET 5310, Industrial Process Controls
- ELET 5330, Instrumentation System Design

Area 4: Computer Systems

- CSCE 5160, Parallel Processing and Algorithms
- CSCE 5450, Programming Languages
- CSCE 5610, Computer System Architecture (core course)
- CSCE 5640, Operating System Design
- CSCE 5650, Compiler Design
- CSCE 6450, Advanced Programming Languages
- CSCE 6610, Advanced Computer Architecture
- CSCE 6640, Advanced Operating Systems
- CSCE 6650, Advanced Compiler Techniques

General Courses

- CSCE 5900-5910, Special Problems
- CSCE 5932, Internship
- CSCE 5934, Directed Study
- CSCE 5950, Master's Thesis

Computer Science Programs

Master of Science

The department offers the Master of Science with a major in computer science.

Admission Requirements

The student must satisfy all the general admission requirements of the Toulouse School of Graduate Studies as well as the following admission requirements of the computer science and engineering department:

1. an acceptable score on the Graduate Record Examination (GRE); contact the department or the Toulouse School of Graduate Studies for information concerning acceptable admission test scores;
2. for applicants whose native language is not English, a TOEFL score of at least 580 for the written test or 237 for the computer test also is required;
3. a GPA of at least 3.0 on the most recent 60 hours of course work;
4. completion of a sufficient amount of prior work in the field of computer science, including courses equivalent to CSCE 2610, 3110, and 3600; some undergraduate leveling sequences are available; and
5. at least 15 hours of mathematics, including differential and integral calculus, discrete mathematics and two other courses selected from statistics, linear algebra, abstract algebra, logic, numerical analysis and differential equations.

An overall evaluation of the student's credentials is used as a basis for admission. Students with an insufficient computer science background may be provisionally admitted to the program and may enroll in graduate-level courses once any required leveling courses are completed with a grade of B or better. Admission is competitive, and satisfaction of the minimum requirements does not guarantee admission.

Admission to Candidacy

After removal of all deficiencies and upon completion of an additional 12 hours of graduate credit, the student is required to submit a formal degree plan to his or her adviser and the dean of the School of Graduate Studies. Failure to fulfill this requirement may prevent the student from enrolling the following term/semester.

Admission to candidacy is granted by the dean of the School of Graduate Studies after the degree plan has been approved.

Degree Requirements

The computer science and engineering department offers two master's degree options:

Option A: Thesis Option (31 hours that include CSCE 5020 and 6 hours of thesis).

Leveling courses cannot be counted toward the degree plan hours.

Option B: Course Option (37 hours that include CSCE 5020 and may include 3 hours of project or 6 hours of problem in lieu of thesis). Leveling courses cannot be counted toward the degree plan hours.

Course Selection

As an introduction to the department and to research in computer science and engineering, all master's students must take CSCE 5020, Current

Research in Computer Science and Engineering, during the first semester they are enrolled in graduate classes.

The Master of Science with a major in computer science includes 9 hours of the following required courses:

- CSCE 5150, Analysis of Computer Algorithms
- CSCE 5450, Programming Languages
- CSCE 5640, Operating System Design

For Option A, the remaining courses are selected in consultation with the student's thesis adviser.

For Option B, the remaining courses are selected in consultation with the graduate coordinator.

Minor

From 6 to 12 hours of graduate work in a minor field of computer science application are required. With prior approval of the graduate coordinator, this work may be done outside the computer science and engineering department.

Academic Standards

If a student's GPA on all graduate and/or deficiency courses falls below 3.0, the student will be placed on probation the following term/semester. Students who cannot raise their GPA above 3.0 during that term/semester will be dropped from the program. To qualify for the master's degree, the student must earn a grade of B or better in each of the core courses.

Graduate Minor in Computer Science

A graduate minor in computer science requires 9 to 12 hours of graduate credit. CSCE 5011-5013 are service courses designed for students who are not computer science majors. Since these are introductory courses, only one of these courses is allowed in the 9-hour minor option, and no more than two of these courses may be included in the 12-hour minor option.

Doctor of Philosophy

The program of study for the doctoral degree with a major in computer science includes formal course work, independent study and research. The purpose of the degree is to produce a professional capable of directing and conducting research within the discipline of computer science.

Admission Requirements

Students seeking admission to the doctoral program must meet all general requirements for doctoral candidates at UNT and must have completed all of the requirements (or equivalent work) for the master's degree as defined in the previous section. Additional requirements are delineated below:

1. an acceptable score on the Graduate Record Examination (GRE); contact the department or the Toulouse School of Graduate Studies for information concerning acceptable admission test scores;
2. a 3.5 GPA on the most recent 30 hours of course work;
3. for applicants whose native language is not English, a TOEFL score of at least 580 for the written test or 237 for the computer test is required; and
4. three letters of recommendation.

An overall evaluation of the student's credentials is used as a basis for admission. Admission is competitive, and satisfaction of the minimum requirements does not guarantee admission.

Degree Requirements

In addition to satisfying the general requirements for all UNT doctoral degrees, a student must satisfactorily complete the following:

1. a minimum of 12 hours of 6000-level organized courses in computer science;
2. the residence requirement, consisting of two consecutive terms/semesters of enrollment in at least 9 semester hours;
3. satisfactory completion of a written comprehensive examination prior to submitting a proposal for dissertation research; and
4. submission and successful defense of the doctoral dissertation.

More detailed information on degree requirements is available upon request from the Department of Computer Science and Engineering.

Language or Tool-Subject Requirements

Consult the graduate adviser, Department of Computer Science and Engineering, for requirements.

Pass-Through Master's (30 hours of course work)

Pass-through degree only. Students who have completed the comprehensive exams may apply for this option after the completion of 40 hours in the doctoral program.

Courses of Instruction

All Courses of Instruction are located in one section at the back of this catalog.

Course and Subject Guide

The "Course and Subject Guide," found in the Courses of Instruction section of this book, serves as a table of contents and provides quick access to subject areas and prefixes.

Department of Electrical Engineering

Main Departmental Office
UNT Research Park, B270
P.O. Box 310470
Denton, TX 76203-0470

(940) 891-6872
Fax: (940) 891-6881

Web site: *www.ee.unt.edu*

Murali Varanasi, Chair

Graduate Faculty: Deng, Fu, Garcia, Guturu, Li, Varanasi.

Introduction

The Department of Electrical Engineering at the University of North Texas commits to achieving excellence in research and graduate education in major electrical engineering areas. Our primary goals include: (1) to provide high quality innovative educational programs at the undergraduate and graduate levels to foster learning, ethical standards, and leadership qualities; (2) to pursue excellence in research at the frontiers of electrical engineering; (3) to facilitate access to our faculty expertise and our modern facilities, and (4) to serve the industry, the profession, and other constituents in North Texas, the state and the nation.

Research

Research areas within the department include the following.

RF and Sensors: Research in this area focuses on the general topics related to advanced RF sensing systems over a wide range of frequencies. The RF sensing systems include radio-frequency identification (RFID) systems, RADAR, remote sensing, medical imaging, underground penetrating and wireless-sensing networking systems.

Computer-Aided Design (CAD) and VLSI: The research interests in this area focus on innovative algorithms for VLSI testing, low-power VLSI design, innovative ASIC and computer architecture, nanoscale logic device modeling, design and simulation, VLSI interconnect modeling and simulation, and VLSI physical design.

Intelligent Signal Processing: Research in this area focuses on the design and development of advanced signal processing algorithms and systems for industrial, space electronic systems and defense technology. The specific research areas include signal detection and estimation, space-time signal processing, signal design and diversity for sensor systems, information fusion from various sensor sources, infrared and microwave imaging, robust signal processing, pattern recognition, and target identification.

Wireless Communications: The research in this area focuses on system-level issues that are critical for the design of high-performance wireless networks and sensor networks. The research topics include measurement and modeling of wireless channels, experimental and theoretical system performance evaluation, channel coding and modulation, integrated communications and positioning, integrated communications and positioning, real-time signal processing, coding, and information theory.

Computer Vision and Image Processing: Research in this area includes object recognition and tracking, dynamic scene analysis pattern recognition, multi-sensor multi-view data fusion, statistical regularization methods for ill-posed problems in vision, and medical imaging.

Other research areas in the department include: These include channel modeling and measurement, innovative wireless imaging systems, analog and mixed-signal IC design, semiconductor device modeling and design, wireless sensor network design, sensor and sensor interface design, bioinformatics, artificial intelligence, speech-driven animation, and cognitively based learning-to-learn education.

Degree Program

The department offers a graduate program leading to the following degree:

- Master of Science with a major in electrical engineering.

Master of Science

Program Objectives

1. Graduates will achieve master's-level proficiency in electrical engineering subjects that include digital integrated circuit design, analog design, adaptive and statistical signal processing, coding theory, control system design, and computer vision and image analysis.
2. Graduates will attain a broad background in electrical engineering that provides them with a number of choices for future specialization, if needed.
3. Graduates will attain proficiency in both oral and written communication that is needed for achieving success in their future careers.
4. Graduates will learn how to learn and thereby attain the ability to pursue life-long learning and continued professional development.

5. Graduates will have experience in project-based learning and hence will be ready to engage in high-tech careers upon their graduation.

Admission Requirements

The student must satisfy all the general admission requirements of the Toulouse School of Graduate Studies as well as the admission requirements of the electrical engineering department as follows:

1. Acceptable score on the Graduate Record Examination (GRE).
2. Acceptable scores on the TOEFL for applicants whose native language is not English.
3. Acceptable GPA on undergraduate electrical engineering course work.
4. Course work in mathematics.

An overall evaluation of credentials is used as a basis for admission to the program. Leveling courses will be required for applicants with degrees other than electrical engineering.

Admission to Candidacy

After removal of all deficiencies and upon completion of all the leveling courses (as described below), the student is required to submit a formal degree plan to his or her adviser and the dean of the School of Graduate Studies. Failure to fulfill these requirements may prevent a student from enrolling the following term/semester. Admission to candidacy is granted by the Dean of Graduate Studies after the degree plan has been approved.

Leveling Courses

- Mathematics through multivariable calculus
- Physics including mechanics, electricity and magnetism
- EENG 2620, Signals and Systems
- EENG 2710, Digital Logic Design
- EENG 3520, Electronics II
- EENG 3810, Communications Systems

All entering students must demonstrate knowledge of the material covered in these courses. An entering student may demonstrate the knowledge by:

- Completing the courses at UNT
- Completing similar courses at another recognized institution
- Evidence based on employment experience.

A student may be required to pass a placement examination to demonstrate his or her knowledge.

Degree Requirements

Option A: Thesis option with 24 semester hours of organized course work excluding undergraduate prerequisites and leveling courses, in addition to 6 hours of EENG 5950, Master's Thesis.

Option B: Non-Thesis option with 30 semester hours of organized course work and 3 semester hours of EENG 5890, Directed Study.

Course Selection

- At least 12 hours of graduate electrical engineering courses.
- No more than 6 semester hours of special problems or directed study courses.
- Leveling courses: Students whose undergraduate majors were not electrical engineering must take additional leveling courses that will be determined by the electrical engineering graduate adviser on an individual basis.

Courses of Instruction

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Course and Subject Guide

The "Course and Subject Guide," found in the Courses of Instruction section of this book, serves as a table of contents and provides quick access to subject areas and prefixes.

Department of Engineering Technology

Main Departmental Office
UNT Research Park, F115
3940 N. Elm St. Suite F 115
Denton, TX 76207-7102

(940) 565-2022
Fax (940) 565-2666

Web site: *www.etec.unt.edu*

Nourredine Boubekri, Chair

Graduate Faculty: Boubekri, Foster, Grubbs, Kougianos, Kozak, Mirshams, Nasrazadani, Plummer, Vaidyanathan, Wang, Yu.

The department serves two basic roles. In the broader sense, it provides exposure to technology for general understanding and interpretation of industry founded in theory and practice. In a more practical sense, the department provides technology-based education that results in professional careers in industry. Career opportunities for graduates are in industry/business.

Research

The research interests of the Department of Engineering Technology are focused on technological systems and processes with specific industrial applications. This research represents the university's desire to effect the transfer of theoretical knowledge from the laboratory to the industrial sector (technology transfer).

Specific interests in mechanical engineering include product design and development, quality assurance, composite materials, materials testing, production planning and management, manufacturing processes, computer-aided design (CAD), computer-aided manufacturing (CAM), computer numerical control (CNC), part programming, electromechanical design, robotics, liquid nitrogen automobile, nano-indentation, field emissions, corrosion and nano crystalline materials, and computer-integrated manufacturing (CIM). The principal research interests in electronics include hardware/software interfacing, data acquisition and analysis, computer-aided software engineering (CASE), local area networks (LANs), digital signal processing, real-time control systems, distributed control systems, RF communication systems, biomedical optics, pulse oximetry, telemedicine, VLSI design of antenna array, SCADA systems, logic circuit design, applications of technology to education, and solar energy research. Also of interest are international projects involving the transfer of electronics technology to the academic and industrial sectors.

Support for research projects in the department has come from the National Science Foundation; American Society for Heating, Refrigeration and Air-conditioning Engineers; American Cancer Society; Cadence Design Systems Inc.; Texas Instruments Inc.; American Society for Engineering Education; Texas Department of Transportation; TU Electric; Electrical Generation Technology; Associated General Contractors of America; Society of Manufacturing Engineers and the U.S. Air Force. Industrial support of graduate student thesis research has been provided by MEMC Southwest, Aerospace Optics, TXU, Manamatsu Photonics, Bell Helicopter-Textron, Texas Instruments, Halsey Engineering and Manufacturing, Molex Inc., Verizon, AT&T, Motorola, Montgomery KONE and Bateman Engineering.

Degree Program

The department offers a graduate program leading to the following degree:

- Master of Science with a major in engineering technology.

Admission Requirements

Admission to graduate study at UNT is described in the Admission section at the front of this catalog.

Applicants should hold an undergraduate degree in a technical field of study. Applicants not meeting this qualification may be admitted with a provision for removal of undergraduate deficiencies. In addition, applicants must meet departmental requirements for the Graduate Record Examination scores. Contact the department or the Toulouse School of Graduate Studies for information concerning acceptable admission test scores.

Master of Science Degree Program

The program of study for the Master of Science with a major in engineering technology is a comprehensive program, yet provides for a degree of specialization with the proper selection of courses in the major. Two options are available.

Option 1, Master of Science, Thesis

The graduate credit requirement for the MS degree is 30 semester hours chosen in one of the following specializations. A formal proposal and an oral defense of the thesis are required of all degree candidates.

Specialization in mechanical engineering technology:

1. Required courses: MSET 5000, 5040, 5950; MEET 5030, 5100, 5120 and 5130.

2. Electives: 8 semester hours selected in consultation with a department graduate adviser.

Specialization in electronics engineering technology:

1. Required courses: MSET 5000 and 5950, and ELET 5300, 5310, 5320, 5330 and 5340.

2. Electives: 8 semester hours selected in consultation with a department graduate adviser.

Option 2, Master of Science, Non-Thesis

The graduate credit requirement for the MS degree is 36 semester hours chosen in one of the following specializations. A project and/or examination is required of all degree candidates for the non-thesis option.

MSET 5000 is required of all students.

Specialization in mechanical engineering technology:

1. Required course: MSET 5040; MEET 5030, 5100, 5120, 5130, 5920 and 5930 (3 hours each).

2. Electives: 14 semester hours selected in consultation with a department graduate adviser.

Specialization in electronics engineering technology:

1. Required courses: ELET 5300, 5310, 5320, 5330, 5340, 5920 and 5930 (3 hours each).

2. Electives: 14 semester hours selected in consultation with a department graduate adviser.

Degree Plan

For advice regarding the procedure for obtaining a degree plan, which is to be submitted prior to the completion of 6 semester hours, see a graduate adviser in the departmental office, UNT Research Park, Room F115.

Financial Support

The department has scholarships and research/teaching assistantships available for full-time graduate students. For additional information, make inquiries to a department graduate adviser.

Courses of Instruction

All Courses of Instruction are located in one section at the back of this catalog.

Course and Subject Guide

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Department of Materials Science and Engineering

Main Departmental Office
UNT Research Park, E132
P.O. Box 305310
Denton, TX 76203-5310
(940) 565-3260

Fax: (940) 565-4824

Web site: *www.mtsc.unt.edu*

Michael Kaufman, Chair

Graduate Faculty: Banerjee, Brostow, D'Souza, El-Bouanani, Gorman, Kaufman, Reidy, Scharf, Shepherd.

The Department of Materials Science and Engineering addresses the educational and technological challenges of creating, applying and characterizing new materials for manufacturing products for the 21st century. The department is committed to training students at the graduate level in all aspects of modern materials including metals, ceramics, polymers, electronic and optical materials, and materials characterization. Students have opportunities for hands-on research with modern equipment and facilities. The department has strong collaborative programs with other universities in the Dallas–Fort Worth region and with corporations throughout the world. Students have many opportunities to develop highly marketable skills for high-technology companies in electronics, chemical, electric power, automotive, aviation, biomedical and environmental industries, as well as academia.

Financial Support

Teaching assistantships funded by the department and research assistantships funded by individual faculty research grants support the majority of students. Out-of-state and international students who are funded at least half-time are eligible for in-state tuition rates. Contact the chair of the Department of Materials Science and Engineering regarding assistantships. Contact Student Financial Aid and Scholarships for student loan information.

Research

The **Electron and Ion Microscopy Laboratory** houses the new FEI TF20ST analytical high-resolution transmission electron microscope and the FEI Nova 200 Nanolab dual-beam scanning electron microscope/focused ion beam instrument. Recent acquisitions include a 3-D local electrode atom probe tomography system, an environmental scanning electron microscope and a high resolution X-ray diffraction system, an atomic force microscope, and a UV-VIS ellipsometer. Full optical microscopy, sample preparation, and electron microscopy computer simulation facilities are available. The multi-disciplinary, multi-user laboratory emphasizes the production and characterization of nanoscale materials and devices and the transfer of technology to industry.

The **Laboratory of Advanced Polymers and Optimized Materials (LAPOM)** focuses on the development of materials with improved mechanical, tribological and thermo-physical properties, including thermoplastics, thermosets, composites, nanohybrids and coatings. High strength, wide service temperature range, low thermal expansivity, low static and dynamic surface friction, high adhesion of coatings to ceramic and metal substrates, high scratch, wear and mar resistance. The analytical characterization facilities include a new 200kV Tecnai G20 analytical high-resolution transmission electron microscope with EDS, PEELS, energy filter and HAADF; a new dual beam Nova 200 focused ionbeam/field emission SEM; a Phillips 420 TEM with EDS; a JEOL 5800 scanning electron microscope (SEM) with EDS; a JEOL T-300 SEM; and a Scintag x-ray diffractometer.

The **Polymer Mechanical and Rheological Laboratory** is engaged in investigations of interrelationships between morphology and mechanical properties

through the influences of time and temperature of polymers, composites and hybrid organic-inorganic nanocomposites. A Mechanical Testing System (MTS810) equipped with an environmental chamber (-150° to 600° C), video and thermal wave imaging provide stress pattern-temperature relationships around propagating cracks and estimate residual stresses. A Torsional Rheometer provides visuelastic and rheological property evaluation. Reliability of dielectric property retention is being examined through simultaneous effects of radiation and electrical fields using thermally stimulated depolarization currents and thermoluminescence.

The **Materials Synthesis and Processing Laboratory** has research interests focused on the development of aerogels and other novel ceramics for dielectric, sensor and high temperature applications. A complete synthesis laboratory is available with several spin coaters for thin film development and with a BET surface area/pore size analyzer for structural characterization as well as high temperature furnaces and a critical point dryer.

The **Display Materials Laboratory** works on field emission displays based on field emission and cathodoluminescence. Display performance is currently restricted by several materials-related limitations. We are investigating these materials-related issues, including low work function materials, thin-film getters and novel spacer materials. We are also studying the reliability of organic light emitting materials and low permeability plastic substrates for flexible displays.

The **Laboratory for Electronic Materials and Devices** is a cross-disciplinary laboratory performing basic and applied research on novel materials for advanced electronic devices of all kinds. The laboratory includes a Group IV molecular beam epitaxy system, a 3 MV ion beam accelerator, a comprehensive surface science system and several scanning probe microscopes. The primary areas of research include advanced dielectric materials, high electric field chemical reactions and molecular electronic devices.

The **Advanced Materials Laboratory** has research focused on the structure-property-processing relationships in metallic structural materials. Current investigations are in the areas of bulk metallic glasses; nanocrystalline materials; development of better aluminum, titanium and nickel alloys for structure applications; and shape memory alloys. Emphasis is on advanced processing and characterization.

The **Energy Materials Laboratory** is focused on developing new materials for advanced energy needs. Of particular interest are processing of nanoscale fuel cells, low-K dielectrics, optoelectronics using precursors, sol-gel and colloidal processing with an emphasis on advanced characterization techniques.

Additional Research Support

Federal support of research projects in the department includes funding from the Defense Advanced Research Projects Agency, the National Science Foundation, the Naval Research Labs, the Army Research Laboratory, U.S. Air Force Office of Scientific Research, U.S. Army Soldier Systems Center and the Department of Education. Other research support has been granted by the Texas Advanced Research Program, the Texas Advanced Technology Program, the Texas Energy Research in Applications Program, Texas Instruments, the Baylor College of Dentistry, Texas Utilities Electric, Bell Helicopter-Textron, Ford Motor Co., Eastman Kodak, General Motors, Sematech, Semiconductor Research Corporation, LTV Corporation, Viratech Thin Films and many small high-technology companies in the Dallas–Fort Worth region. Current funding sources include Carbon Nanotechnologies Inc., NASA, Army Soldier systems, The Naval Research Laboratory, the Army Research Office, Zyvex, Semiconductor Research Corporation, the Texas Advanced Research Program and the Texas Advanced Technology Program.

Admission Requirements

The student must apply for and be granted admission through the office of the dean of the Toulouse School of Graduate Studies; admission requirements applicable to all departments are found in the Admission section of this catalog or at *www.gradschool.unt.edu*. Students may also contact the program for current admission requirements.

Admission to the graduate degree programs in materials science is competitive, as available facilities do not permit admission of all qualified applicants. Departmental forms for applying for financial aid may be obtained from the chair of the Department of Materials Science and Engineering or from the web site (*www.mtsc.unt.edu/03PerspectiveStudents/Graduate.htm*). Students currently enrolled in MS degrees (non materials science) at UNT need to reapply for admission to the department of materials science through the graduate school in order to concurrently avail of the dual degree option (see dual degrees in the Admission section of this bulletin). Candidates applying for a dual degree need not resubmit original documents. Application does not imply admission.

Applying is a two-part process. First, prospective applicants for graduate degree programs must obtain and file an application for admission to the UNT graduate school from the graduate dean's office. Second, applicants for graduate materials science degrees must send in a complete copy of the graduate school

application, GRE scores, TOEFL scores (if required), original college transcripts, a curriculum vitae, statement of research interests and at least two recommendation letters. If original GRE and TOEFL scores have been sent to the graduate school, a copy of scores can be sent to the department. If financial assistance in the form of a research or teaching assistantship is being sought, this should be requested in a cover letter to the department or by filling out the online request form at *www.mtsc.unt.edu/03PerspectiveStudents/Graduate.htm.*

Admission to the MS (problems-in-lieu-of thesis), MS (thesis) and PhD programs are based on a cumulative assessment of GRE, letters of recommendation and college transcripts. For admission, students must present acceptable scores on the Graduate Record Examination (GRE). Contact the department or the Toulouse School of Graduate Studies concerning standardized admission test requirements. International applicants must also provide a minimum of 550 (paper) or 216 (computer based) on the TOEFL (Test of English as a Foreign Language) exam. Complete college transcripts and two letters of recommendation are required. Further details may be obtained from the departmental office.

Degree Programs

The Department of Materials Science and Engineering offers graduate programs leading to the following degrees:

- Master of Science with a major in materials science and engineering, and
- Doctor of Philosophy with a major in materials science and engineering.

Master's Degree Options

The applicant seeking a master's degree with a major in materials science and engineering will plan a degree program with the assistance of the student's major professor and the advisory committee. A graduate major must present credit for at least 32 semester credit hours. The student must maintain a B average in all formal materials science courses.

Option 1, Master of Science, Thesis

The applicant seeking a master's degree with a major in materials science and engineering will plan a degree program with the assistance of the student's major professor and the advisory committee. A graduate major must present credit for at least 32 semester credit hours. The student must maintain a B average in all formal materials science courses.

1. **Core Courses** (12 hours)

- MTSE 5000, Thermodynamics of Materials
- MTSE 5010, Bonding, Structure and Crystallography
- MTSE 5500, Electronic, Optical and Magnetic Materials
- MTSE 6100, Mechanical Properties of Materials

2. **Electives** (12 hours)

Twelve hours may be chosen from materials science or related fields, as approved by the major professor and the advisory committee.

3. **Seminar in Materials Science and Engineering** (2 hours minimum)

- MTSE 5700, Seminar in Materials Science and Engineering

Please see "Seminar in Current Topics in Materials Science" below.

4. **Thesis** (6 hours minimum)

- MTSE 5950, Master's Thesis

Work for the master's thesis is comprised of independent and original studies that may be experimental, computational, theoretical or a combination of these. As part of these requirements, the student must present a formal written report that must be approved by the major professor and the advisory committee and filed in the graduate dean's office. Reports for MTSE 5950 must be submitted in a form prescribed by one of the common refereed materials science journals, such as the manuscript form of the American Institute of Physics (see AIP style manual, current edition). See also the graduate school thesis requirements at *www.gradschool.unt.edu.*

Option 2, Master of Science, Problems in Lieu of Thesis

The graduate credit requirement for the Master of Science degree is 35 semester hours chosen in the following manner.

1. **Core Courses** (12 hours)

- MTSE 5000, Thermodynamics of Materials
- MTSE 5010, Bonding, Structure and Crystallography
- MTSE 5500, Electronic, Optical and Magnetic Materials
- MTSE 6100, Mechanical Properties of Materials

2. **Electives** (12 hours)

Fifteen hours may be chosen from materials science or related fields, as approved by the major professor and the advisory committee.

3. **Seminar in Materials Science and Engineering** (2 hours minimum)

- MTSE 5700, Seminar in Materials Science and Engineering

Please see "Seminar in Current Topics in Materials Science" below.

4. **Problem in Lieu of Thesis** (6 hours)

- MTSE 5920, Research Problems in Lieu of Thesis

• MTSE 5930, Research Problems in Lieu of Thesis

Research problems in lieu of thesis are independent, original studies that may be experimental, computational, theoretical or a combination of these. As part of the requirements for each problems course, the student must present a formal written report of the work done in the course, which must be approved by the major professor and the advisory committee. Reports for MTSE 5920-5930 must be submitted in a form prescribed by one of the common refereed materials science journals, for example, in the manuscript form prescribed by the American Institute of Physics (see AIP style manual, current edition).

Seminar in Current Topics in Materials Science

All MS (thesis) and PhD students are expected to attend MTSE 5700 during each term/semester of full-time graduate study. Candidates for a Master of Science (thesis) degree must present their work during the regularly scheduled departmental seminar prior to the oral examination before the graduate committee. Candidates for the Master of Science (problems in lieu of thesis) must give a seminar based on the reports written for MTSE 5920-5930 and obtain a minimum grade of B for the seminar. The thesis/problem adviser must be present for the seminar presentation.

Examinations

An entrance interview and proficiency examination concerning fundamental materials science is required of all students. The results are used for advisory, placement and remedial purposes.

An oral presentation of the master's thesis is required. A decision on acceptance of the thesis is made by the student's advisory committee after an oral examination is successfully completed. A decision on the acceptance of a written report based on problems in lieu of thesis is made by the student's advisory committee. Guidelines for thesis preparation are available from the department secretary. See also the graduate school requirements at *www.gradschool.unt.edu.*

Doctor of Philosophy

The Doctor of Philosophy degree represents the attainment of a high level of scholarship and achievement in independent research that culminates in the completion of a dissertation of original scientific merit. Hence, it cannot be prescribed in terms of a fixed semester credit hour requirement.

Generally, the degree consists of 90 semester credit hours beyond a bachelor's degree and 60 hours beyond the master's degree, with 12 semester credit hours allocated for the dissertation.

It is expected that the candidate will have published at least one original research article in a refereed journal prior to graduation.

Admission to the Doctoral Program

Departmental admission to the doctoral program in materials science (as distinguished from admission to candidacy for the PhD program) requires a satisfactory score on the written and oral sections of the qualifying examination. (See "Examinations" section below.) A candidate has a maximum of two and a half years following entrance into the doctoral program to be admitted to candidacy. Contact the Toulouse School of Graduate Studies or the program for current admission requirements, or see information posted on the graduate school web site at *www.gradschool.unt.edu.*

Approximately a year after the candidate is admitted to candidacy, the student is examined on the chosen area of specialization: metallic, ceramic, polymer or electronic materials. (See "Examinations" section below for details.)

Enrollment in MTSE 6950 is not allowed until the student has been admitted to candidacy and has successfully passed the examination on the chosen specialization.

Examinations

1. A written qualifying examination is taken after completion of the core curriculum courses over the contents of these courses. This examination is generally conducted in the summer term/semester.

2. After passing the written exam, students are required to complete and defend an original proposal unrelated to their research.

3. Upon passing the written and oral examination by the examination committee, the applicant is admitted to candidacy.

4. A comprehensive oral exam related to the area of specialization of the student (metallic, ceramic, polymer or electronic materials), not to be confused with the student's PhD dissertation defense, is taken by doctoral candidates approximately one year after they have completed the qualifying and written exam.

5. Details of the examination schedule, expectations and criteria for successful completion are available in the Materials Science Graduate Student Handbook available in the department office and posted to the department web site.

Final Examination

This oral examination is primarily a defense of the dissertation, which must be submitted in final form to the final examination committee at least seven days prior to the scheduled oral examination.

Course Work

For the student who has a BS degree, the approximate requirements follow:

1. **Core Courses** (12 hours)

• MTSE 5000, Thermodynamics of Materials

- MTSE 5010, Bonding, Structure and Crystallography
- MTSE 5500, Electronic, Optical and Magnetic Materials
- MTSE 6100, Mechanical Properties of Materials

2. **Electives** (30 hours)

Thirty credit hours may be chosen from materials science or related fields, as approved by the major professor and the advisory committee.

3. **Individual Research** (26–34 hours)

- MTSE 6940, Individual Research

Additional course work may be taken in lieu of individual research hours.

4. **Seminar in Materials Science and Engineering** (2–10 hours)

- MTSE 5700, Seminar in Materials Science and Engineering

Please see "Seminar in Current Topics in Materials Science".

5. **Dissertation** (12 hours minimum)

- MTSE 6950, Doctoral Dissertation

Seminar in Current Topics in Materials Science and Engineering

All doctoral students are expected to attend MTSE 5700 during each term/semester of full-time graduate study. A seminar based on the student's dissertation research must be given during the regularly scheduled class time prior to and in addition to the formal defense of the dissertation.

Minor in Materials Science and Engineering

Students pursuing degrees in other disciplines can apply for a minor in materials science through the department office. The minor of materials science requires 12 hours of materials science related course work approved by the department graduate adviser.

Courses of Instruction

All Courses of Instruction are located in one section at the back of this catalog.

Course and Subject Guide

The "Course and Subject Guide," found in the Courses of Instruction section of this book, serves as a table of contents and provides quick access to subject areas and prefixes.

Department of Mechanical and Energy Engineering

Main Departmental Office
UNT Research Park, F101
P.O. Box 311098
Denton, TX 76203-1098
(940) 565-2400
Fax (940) 369-8675

Web site: *www.mee.unt.edu*

Efstathios E. Michaelides, Chair

Graduate Faculty: Boetcher, Choi, Feng, Michaelides.

The Department of Mechanical and Energy Engineering at the University of North Texas is committed to academic excellence in graduate education and research in all areas pertinent to energy conservation and thermal engineering. The goals of the department and its faculty are (1) to provide high quality and innovative educational programs at the undergraduate and graduate levels; to foster lifelong learning; to promote professionalism and ethical standards; and to help students develop leadership qualities; (2) to pursue excellence in scholarly research in areas of mechanical and energy engineering; (3) to collaborate with engineers in industry, national laboratories and government agencies in the solution of national and global problems related to energy use and its environmental impacts.

Research

Research areas within the department include the following:

- **Advanced energy conversion** with applications to energy conversion, alternative energy sources, and energy conservation methods and systems.
- **Computational fluid dynamics (CFD) and computational heat transfer (CHT)** with applications to environmental effects of energy production, global environmental changes, buoyant flows, fluid distribution manifolds, biological flow and heat transfer, and thermal characteristics of electronic equipment.
- **Micro/nano-scale science and technology** with applications to femto-second laser machining, plasma dynamics, nano-scale fabrication, non-tube properties and the transport properties of micro- and non-particles.
- **Particulate and multiphase flow and heat transfer** with applications to the combustion of fuels, fluidized bed reactors, sedimentation, aerosols and environmental effects of energy production.

Degree Program

The department offers a graduate program leading to the following degree:

- Master of Science with a major in mechanical and energy engineering.

Admission Requirements

The admission process has two parts:

1. Students must apply through the appropriate University admissions office and meet the minimum requirements for graduate admission to the University of North Texas.

U.S. students submit the Toulouse School of Graduate Studies application online and send by mail the application fee and official transcripts from all universities or colleges attended. For details visit *www.gradschool.unt.edu*.

International students must apply through the International Admissions Office online and send by mail the application fee and official academic documentation from all schools attended. For details visit *www.international.unt.edu*.

2. Students also submit the following materials directly to the Department of Mechanical and Energy Engineering:

- a detailed resume that includes educational experience; relevant work history; and research experience,
- three letters of recommendation, and
- official scores for the Graduate Record Examination (GRE) for all three sections.*

** The department does not require GRE scores from UNT graduates for admission to its program. However, students who apply for financial aid are strongly encouraged to take the GRE.*

Master of Science Degree Program

All students pursuing the master's degree with a major in mechanical and energy engineering must plan their degree program with the assistance of their major professor and their advisory committee. The requirement for graduation is at least 30 semester credit hours and maintenance of at least a B average in all graduate courses. All candidates for the masters' degree must take the following required courses:

- MEEN 5100, Advanced Energy Conversion, 3 hours
- MEEN 5110, Alternative Energy Sources, 3 hours
- MEEN 5112, Nuclear Energy, 3 hours
- MEEN 5120, Advanced Fluid Dynamics, 3 hours
- MEEN 5220, Computational Fluid Dynamics and Heat Transfer, 3 hours
- MEEN 5900, Special Problems (when taught as "Advanced Mathematical Methods"), 3 hours

Option 1, Master of Science, Thesis

The graduate credit requirement for the Master of Science degree is 30 semester credit hours chosen as follows:

1. Twenty-four semester credit hours of course work chosen from the graduate-level courses offered by the university. A minimum of 18 semester credit hours of this course work must be chosen from the graduate-level (5000 or higher) courses offered by the Department of Mechanical and Energy Engineering. The rest of the course work may be chosen from other departments with the approval of the department chair and the student's major professor.

2. Six semester credit hours of MEEN 5950 (Master's Thesis). Work for the master's thesis is comprised of an independent and original study. As part of these requirements, the student must present and defend a written thesis that must be approved by the major professor and the advisory committee and filed with the graduate dean's office. The thesis must conform to the graduate school thesis requirements, which may be found at *www.gradschool.unt.edu*. It is expected that this material will be of archival quality.

Option 2, Master of Science, Non-Thesis

The graduate credit requirement for the MS degree is 30 semester credit hours chosen as follows:

1. Thirty semester credit hours of course work chosen from the graduate level courses offered by the university. A minimum of 21 semester credit hours of course work must be chosen from the graduate level courses offered in the area of mechanical and energy engineering. The rest of the course work may be chosen from other departments with approval of the department chair and the student's major professor.

2. The students in this option must compose a report on an independent research problem and give a formal seminar/presentation to his or her advisory committee.

Examinations

An oral presentation of the master's thesis is required. A decision on acceptance of the thesis will be made by the student's advisory committee. A decision on the acceptance of the report for an independent research problem will be made by the student's advisory committee. Guidelines for the independent research problem and thesis preparation may be found at *www.mee.unt.edu*. For the thesis, additional preparation guidelines can be found at *www.gradschool.unt.edu.*

Courses of Instruction

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Course and Subject Guide

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