SMU

Bobby B. Lyle School of Engineering

Graduate Programs

Southern Methodist University

2009–2011

NOTICE OF NONDISCRIMINATION

Southern Methodist University will not discriminate in any employment practice, education program or educational activity on the basis of race, color, religion, national origin, sex, age, disability or veteran status. SMU's commitment to equal opportunity includes nondiscrimination on the basis of sexual orientation. The director of Institutional Access and Equity has been designated to handle inquiries regarding the nondiscrimination policies.

BULLETIN OF SOUTHERN METHODIST UNIVERSITY

VOL. LXXXIX 2009–2011

The following catalogs constitute the General Bulletin of the University:

Undergraduate Catalog
Dedman School of Law Catalog
Perkins School of Theology Catalog
Dedman College Graduate Catalog
Cox School of Business Graduate Catalog
Meadows School of the Arts Graduate Catalog
Annette Caldwell Simmons School of Education and Human Development Catalog
Lyle School of Engineering Graduate Catalog

In addition, certain academic programs provide their own schedules and catalogs:

Continuing Education
Summer Studies
International Programs
SMU-in-Taos (Fort Burgwin)

Every effort has been made to include in this catalog information that, at the time of preparation for printing, most accurately represents Southern Methodist University. The provisions of the publication are not, however, to be regarded as an irrevocable contract between the student and Southern Methodist University. The University reserves the right to change, at any time and without prior notice, any provision or requirement, including, but not limited to, policies, procedures, charges, financial aid programs, refund policies and academic programs. Additional information may be obtained by writing to the offices listed below:

Admissions: *Undergraduate:* Executive Director of Enrollment Services and Undergraduate Admission
Graduate: Dean's Office of school – arts, business, engineering, law, theology; for humanities and sciences – Research and Graduate Studies Office

Employment: *Off Campus:* Hegi Family Career Development Center
On Campus: Division of Enrollment Services – Financial Aid

Financial Information on Tuition and Fees: Division of Enrollment Services – Student Financial Services

Housing: Department of Residence Life and Student Housing

Loans: Division of Enrollment Services – Financial Aid

Registration and Academic Records: Division of Enrollment Services – University Registrar

Scholarships: Division of Enrollment Services – Financial Aid

All addresses are as below:
Southern Methodist University
Dallas TX 75275

Information also is available on the website smu.edu.

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Southern Methodist University
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2009

Contents

OFFICIAL UNIVERSITY CALENDAR 6
DESCRIPTION OF THE UNIVERSITY 10
FINANCIAL INFORMATION 12
POLICIES AND PROCEDURES 14
UNIVERSITY LIFE AND SERVICES 22
EDUCATIONAL FACILITIES 29
OFFICE OF INFORMATION TECHNOLOGY 34
SPECIAL ACADEMIC PROGRAMS 35
RIGHT TO KNOW 38
GENERAL INFORMATION 40
MASTER OF SCIENCE DEGREE 43
OFF-CAMPUS DISTANCE EDUCATION 50
DOCTOR OF ENGINEERING DEGREE 51
DOCTOR OF PHILOSOPHY DEGREE 55
PROGRAMS AND COURSES 60
Computer Science and Engineering 60
Master of Science in Computer Engineering 61
Master of Science (Major in Computer Science) 64
Master of Science (Major in Security Engineering) 68
Master of Science (Major in Software Engineering) 69
Doctor of Philosophy (Major in Computer Engineering) 71
Doctor of Philosophy (Major in Computer Science) 75
Doctor of Engineering (Major in Software Engineering) 79
Certificate Programs 82
Electrical Engineering 90
Master of Science in Electrical Engineering 91
Master of Science in Electrical Engineering (Telecommunications Specialization) 93
Master of Science (Major in Telecommunications) 94
Doctor of Philosophy (Major in Electrical Engineering) 95
Engineering Management, Information and Systems 109
Master of Science (Major in Operations Research) 110
Master of Science (Major in Systems Engineering) 112
Master of Science in Engineering Management 114
Master of Science in Information Engineering and Management 114
Multiple Master's Degrees 116
EMIS Executive Master's Programs 117
Doctor of Philosophy (Major in Operations Research) 117
Doctor of Philosophy (Major in Systems Engineering) 120
Doctor of Engineering (Major in Engineering Management) 123
Certificate Series in Systems Engineering 125
Certificate Series in Information Engineering and Management 126
Environmental and Civil Engineering 134
Master of Science in Environmental Engineering 136
Master of Science in Environmental Science (Major in Environmental Science) 137
(Major in Environmental Systems Management) 139
(Major in Hazardous and Waste Materials Management) 140
Master of Science in Civil Engineering 141
Master of Science in Facilities Management 143
Doctor of Philosophy (Major in Civil Engineering) 144
Professional Certificates 146
Mechanical Engineering 155
Master of Science in Mechanical Engineering 156
Master of Science (Major in Manufacturing Systems Management) 157
Professional Certificate in Manufacturing Management Fundamentals 158
Master of Science (Major in Packaging of Electronics and Optical Devices) 158
Professional Certificate in Electronic Packaging Fundamentals 159
Doctor of Philosophy (Major in Mechanical Engineering) 160
ADMINISTRATION AND FACULTY 170

Official University Calendar

ACADEMIC YEAR 2009–2010

This calendar includes an addendum listing religious holidays for use in requesting excused absences according to University Policy 1.9. For religious holidays not listed, the instructor or supervisor may contact the Office of the Chaplain.

Graduate programs in the Cox School of Business, Perkins School of Theology and Dedman School of Law have different calendars.

Offices of the University will be closed on September 7, November 26–27, December 21–25, 2009; January 1, January 18, April 2, May 31 and July 5, 2010.

FALL TERM 2009

March 30–April 17, Monday–Friday: Enrollment fall 2009 continuing students for all undergraduates and graduate Dedman and Meadows.

May/July/August: Academic Advising, Enrollment and Orientation (AARO) conferences for new first-year and transfer undergraduate students. For a list of dates, contact New Student Programs, Student Life Office; 214-768-4560; smu.edu/newstudent.

August 23, Sunday: Residence halls officially open.

August 25, Tuesday: Opening Convocation, McFarlin Auditorium.

August 26, Wednesday: First day of classes.

September 1, Tuesday: Last day to enroll, add courses or drop courses without grade record or tuition billing. Last day to file for graduation in December.

September 7, Monday: University holiday – Labor Day.

September 9, Wednesday: Follows Monday class schedule.

September 11, Friday: Last day to declare pass/fail, no credit or first-year repeated course grading options. Last day to request excused absence for observance of a religious holiday.

October 7, Wednesday: Last day for continuing undergraduate students to change their majors before November enrollment.

October 12–13, Monday–Tuesday: Fall break.

November 2–November 20, Monday–Friday: Enrollment spring 2010 continuing students for all undergraduates and graduate Dedman and Meadows.

November 3, Thursday: 60 percent point of the term that federal financial aid has been earned if a student officially withdraws from SMU. Prior to this date, a partial calculated return to federal programs will be required.

November 6–7, Friday–Saturday: Homecoming.

November 10, Tuesday: Last day to drop a course.

November 13–14, Friday–Saturday: Family weekend.

November 16, Monday: Last day for December graduation candidates to change grades of Incomplete.

November 24, Tuesday: Students should file for May graduation. Last day to file is January 21.

November 25, Wednesday: No classes.

November 26–27, Thursday–Friday: University holiday – Thanksgiving.

December 1, Tuesday: Last day to withdraw from the University.

December 4–9, Friday–Wednesday: No final examinations or unscheduled tests and papers.

December 7, Monday: Last day for oral/written examinations for December graduate degree candidates.

December 9, Wednesday: Last day of instruction.

December 10, Thursday: Reading day.

December 11–17, Friday–Thursday: Examinations. (No examinations scheduled for Sunday.)

December 18, Friday: Residence halls officially close. (December graduates contact RLSH.)

December 19, Saturday: Official close of term and date for conferral of degrees. Graduation ceremony for December graduates.

December 21–25, Friday: University holidays – Christmas/winter break.

JANUARY INTERTERM 2010

January 1, Friday: University holiday – New Year's Day.

(Note: Some areas of instruction offer selected courses during the January interterm, December 22–January 19.)

SPRING TERM 2010

November 2–January 25, Monday–Thursday: Enrollment spring 2010 continuing students for all undergraduates and graduate Dedman and Meadows.

January – TBA: Academic Advising, Enrollment and Orientation (AARO) conferences for new first-year and transfer undergraduate students. Conference dates to be announced. Contact New Student Programs, Student Life Office; 214-768-4560; smu.edu/newstudent.

January 1, Friday: University holiday – New Year's Day.

January 12, Tuesday: Residence halls officially open.

January 18, Monday: University holiday – Birthday of Martin Luther King, Jr.

January 19, Tuesday: First day of classes.

January 25, Monday: Last day to enroll, add courses or drop courses without grade record or tuition billing. Last day to file for May graduation.

February 3, Wednesday: Last day to declare pass/fail, no credit or first-year repeated course grading options. Last day to request excused absence for observance of a religious holiday.

March 6–14, Saturday–Sunday: Spring break.

March 31, Wednesday: 60 percent point of the term that federal financial aid has been earned if a student officially withdraws from SMU. Prior to this date, a partial calculated return to federal programs will be required.

April 2, Friday: University holiday – Good Friday.

April 4, Sunday: Easter Sunday.

April 5–23, Monday–Friday: Enrollment summer 2010 and fall 2010 continuing students for all undergraduates and graduate Dedman and Meadows.

April 5, Monday: Last day for continuing undergraduate students to change their majors before April enrollment.

April 8, Thursday: Last day to drop a course.

April 12, Monday: Last Day for May graduation candidates to change grades of Incomplete.

April 20, Tuesday: Students should file for August or December graduation. Last day to file for August is June 4. Last day to file for December is the last day to enroll for fall 2010.

April 26, Monday: Last day to withdraw from the University.

April 29–May 4, Thursday–Tuesday: No final examinations or unscheduled tests and papers.

April 30, Friday: Last day for oral/written examinations for graduate students who are May degree candidates.

May 4, Tuesday: Last day of instruction. Follows a Friday schedule.

May 5–11, Wednesday–Tuesday: Examinations. (No examinations scheduled for Sunday.)

May 12, Wednesday: Residence halls officially close for nongraduating students.

May 14, Friday: Baccalaureate.

May 15, Saturday: Commencement.

May 16, Sunday: Residence halls close for graduating students.

MAY TERM 2010

Some areas of instruction may offer a limited number of selected courses during the May term period, May 12–30. Each May term course may have unique start and end dates within the May 12–30 term to accommodate the particular needs of the course.

The following dates are applicable only for courses offered at the Taos campus:

May 12, Wednesday: SMU-in-Taos: May term travel day and arrival, 2–6 p.m.

May 13, Thursday: SMU-in-Taos: First day of classes.

May 14, Friday: SMU-in-Taos: Last day to enroll, add courses and drop courses without grade record or tuition billing. Permission of Taos Program required for all enrollments.

May 29, Saturday: SMU-in-Taos: May term examinations.

May 30, Sunday: SMU-in-Taos: May term departure.

SUMMER TERM 2010

The summer term consists of three primary sessions: first session, second session and a 10-week full session. There are also shorter and longer sessions to accommodate the particular needs of the various instructional units such as SMU-In-Taos, international programs and Perkins School of Theology.

Full Summer Session

Classes will meet 2 hours and 15 minutes twice a week or 1 hour and 30 minutes three times a week.

May 31, Monday: University holiday – Memorial Day.
June 1, Tuesday: First day of full summer session classes.
June 4, Friday: Last day to enroll, add courses or drop courses without grade record or tuition billing for full session course. Last day to file for August graduation.
June 10, Thursday: Last day to declare pass/fail, no credit or first-year repeated course grading options for a full session course.
July 4–5, Sunday–Monday: University holiday – Independence Day.
July 6, Tuesday: Follows a Monday class schedule.
July 10, Saturday: 60 percent point of the term that federal financial aid has been earned if a student officially withdraws from SMU. Prior to this date, a partial calculated return to federal programs will be required.
July 16, Friday: Last day for August graduation candidates to change grades of Incomplete.
July 23, Friday: Last day to drop a full summer session course.
July 29, Thursday: Last day to withdraw from the University.
August 4, Wednesday: Last day of full summer session instructions and examinations. Close of the term and conferral date.

First Session

Classes meet two hours a day, Monday–Friday.

May 31, Monday: University holiday – Memorial Day.
June 1, Tuesday: First day of first session classes.
June 2, Wednesday: Last day to enroll, add courses or drop courses without grade record or tuition billing for a first session course.
June 4, Friday: Last day to declare pass/fail, no credit or first-year repeated course grading options for a first session course. Last day to file for August graduation.
June 19, Saturday: 60 percent point of the term that federal financial aid has been earned if a student officially withdraws from SMU. Prior to this date, a partial calculated return to federal programs will be required.
June 23, Wednesday: Last day to drop a first session course.
June 24, Thursday: Last day to withdraw from the University.
June 30, Wednesday: Last day of first session instruction and examinations.

Taos Summer I Session

June 3, Thursday: SMU-in-Taos: Summer I arrival and first day of classes.
June 4, Friday: SMU-in-Taos: Last day to enroll, add courses and drop courses without grade record or tuition billing. Permission of Taos Program required for all enrollments.
June 30, Wednesday: SMU-in-Taos: Summer I examinations.
June 30, Wednesday: SMU-in-Taos: Summer I departure.

Second Session

Classes meet two hours a day, Monday–Friday.

June 4, Friday: Last day to file for August graduation.
July 1, Thursday: First day of second session classes.
July 2, Friday: Last day to enroll, add courses or drop without grade record or tuition billing for second session courses.
July 4–5, Sunday–Monday: University holiday – Independence Day.
July 6, Tuesday: Last day to declare pass/fail, no credit or first-year repeated course grading options for a second session course.
July 13, Tuesday: Last day for August graduation candidates to change grades of Incomplete.
July 23, Friday: Last day to drop a second session course.
July 24, Saturday: 60 percent point of the term that federal financial aid has been earned if a student officially withdraws from SMU. Prior to this date, a partial calculated return to federal programs will be required.
July 27, Tuesday: Last day to withdraw from the University.
August 2, Monday: Last day of second session instruction and examinations.
August 4, Wednesday: Official close of the term and conferral date.

Taos August Term 2010

August 5, Thursday: SMU-in-Taos: August term arrival and first day of classes, 2–6 p.m.
August 6, Friday: SMU-in-Taos: Last day to enroll, add courses and drop courses without grade record or tuition billing. Permission of Taos Program required for all enrollments.
August 22, Sunday: SMU-in-Taos: August term examinations.
August 23, Monday: SMU-in-Taos: August term departure.

MAJOR RELIGIOUS HOLIDAYS

(August 2009–August 2010)

Listing of religious holidays for use in requesting excused absences according to University Policy 1.9. For religious holidays not listed, the instructor or supervisor may contact the Office of the Chaplain.

Christian

Christmas: December 25, 2009
Ash Wednesday: February 17, 2010
Palm Sunday: March 28, 2010
Good Friday: April 2, 2010
Easter Sunday: April 4, 2010
Easter Sunday (Orthodox): April 4, 2010

Hindu

Janmashtami: August 28, 2009
Dasera: October 9, 2009
Diwali: October 28, 2009

Jewish

All holidays begin at sundown before the first day noted and conclude at sundown on the day(s) noted.

Rosh Hashanah: September 28–30, 2009
Yom Kippur: October 7, 2009
Sukkot: October 12–14, 2009
Hanukkah: December 21–28, 2009
Purim: March 8–9, 2010
Pesach (Passover): April 7–15, 2010
Shavuot: May 28–30, 2010

Muslim

Ramadan: September 1–2, 2009
Eid al Fitr: September 30–October 1, 2009
Eid al Adha: December 7–8, 2009
Islamic New Year: December 29, 2009
Ashura: January 7, 2010
Mawlid al Nabi: March 8–9, 2010

THE VISION OF SOUTHERN METHODIST UNIVERSITY

To create and impart knowledge that will shape citizens who contribute to their communities and lead their professions in a global society.

THE MISSION OF SOUTHERN METHODIST UNIVERSITY

Southern Methodist University's mission is to be a leading private institution of higher learning that expands knowledge through research and teaching. Among its faculty, students and staff, the University develops skills and cultivates principled thought and wisdom. The University is dedicated to the values of academic freedom and open inquiry and to its United Methodist heritage.

To fulfill its mission the University strives for quality, innovation and continuous improvement as it pursues the following goals:

- To enhance the academic quality and competitiveness of the University.
- To improve teaching and learning.
- To strengthen scholarly research and creative achievement.
- To support and sustain student development and quality of life.
- To broaden global perspectives.
- To advance the University through select, strategic alliances.

SOUTHERN METHODIST UNIVERSITY

As a private, comprehensive university enriched by its United Methodist heritage and its partnership with the Dallas Metroplex, Southern Methodist University seeks to enhance the intellectual, cultural, technical, ethical and social development of a diverse student body. SMU offers undergraduate programs centered on the liberal arts; excellent graduate, professional and continuing education programs; and abundant opportunities for access to faculty in small classes, research experience, international study, leadership development and off-campus service and internships, with the goal of preparing students to be contributing citizens and leaders for our state, the nation and the world.

SMU comprises seven degree-granting schools: Dedman College of Humanities and Sciences, Meadows School of the Arts, Edwin L. Cox School of Business, Annette Caldwell Simmons School of Education and Human Development, Bobby B. Lyle School of Engineering, Dedman School of Law and Perkins School of Theology.

Founded in 1911 by what is now the United Methodist Church, SMU is nonsectarian in its teaching and is committed to the values of academic freedom and open inquiry.

The University has 104 buildings, a total enrollment that has averaged more than 10,000 the past 10 years, a full-time faculty of 656, and assets of $260,460,000 – including an endowment of $1,363,846,000 (Market Value, June 30, 2008).

Of the 10,965 students enrolled for the 2008 fall term, 6,240 were undergraduates and 4,725 were graduate and professional students. The full-time equivalent enrollment was 6,073 for undergraduates and 3,121 for graduate and professional students.

Nearly all the students in SMU's first class came from Dallas County, but now 47 percent of the University's undergraduate student body comes from outside Texas. In a typical school year, students come to SMU from every state, from 92 foreign countries, and from all races, religions and economic levels.

Undergraduate enrollment is 54 percent female. Graduate and professional enrollment is 44 percent female.

A majority of SMU undergraduates receive some form of financial aid. In 2008–2009, 77.1 percent of first-year students received some form of financial aid, and 25.0 percent of first-year students received need-based financial aid.

Management of the University is vested in a Board of Trustees of civic, business and religious leaders – Methodist and non-Methodist. The founders' first charge to SMU was that it become not necessarily a great *Methodist* university, but a great *university*.

ACADEMIC ACCREDITATION

Southern Methodist University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award baccalaureate, masters and doctorate degrees. Contact the Commission on Colleges at 1866 Southern Lane, Decatur, Georgia 30033-4097 or call 404-679-4500 for questions about the accreditation of Southern Methodist University.

Individual academic programs are accredited by the appropriate national professional associations. The Cox School of Business is accredited by AACSB International – the Association to Advance Collegiate Schools of Business. The Dedman School of Law is accredited by the American Bar Association. Perkins School of Theology is accredited by the Association of Theological Schools in the United States and Canada. The Department of Chemistry is accredited by the American Chemical Society. In the Meadows School of the Arts, the Dance Division is accredited by the National Association of Schools of Dance, the Music Division by the National Association of Schools of Music, and the Theatre Division by the National Association of Schools of Theater.

The Lyle School of Engineering undergraduate programs in civil engineering, computer engineering, electrical engineering, environmental engineering and mechanical engineering are accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700. The undergraduate computer science program that awards the degree Bachelor of Science (B.S.) is accredited by the Computing Accreditation Commission of ABET. The undergraduate computer science program that awards the degree Bachelor of Arts (B.A.) is not accredited by a Commission of ABET. ABET does not provide accreditation for the disciplines of environmental science and management science.

Financial Information

A catalog supplement, *Financial Information: Southern Methodist University,* is issued each academic year. It provides the general authority and reference for SMU financial regulations and obligations, as well as detailed information concerning tuition, fees and living expenses.

The supplement is available on the Bursar website at smu.edu/bursar. For more information, call 214-768-3417.

Students registering in Continuing Student Enrollment must ensure that payment is received in the Division of Enrollment Services by the due date (published on the Bursar website). No confirmation of receipt of payment will be sent. Invoice notifications are e-mailed to the student's SMU e-mail address after registration for the student to view on the Web. If notification has not been received two weeks prior to the due date, Enrollment Services should be contacted. The registration of a student whose account remains unpaid after the due date may be canceled at the discretion of the University. Students registering in New Student Enrollment and Late Enrollment must pay at the time of registration.

Students are individually responsible for their financial obligations to the University. All refunds will be made to the student, with the exception of PLUS loans and the SMU Monthly Payment Plan. If the refund is issued by check, the student may request, in writing, that the refund be sent to another party. Any outstanding debts to the University will be deducted from the credit balance prior to issuing a refund check. Students with Title IV financial aid need to sign an Authorization to Credit Account form. Students with a PLUS Loan need to have the parent sign an Authorization to Credit Account Parent) form. A student whose University account is overdue or who is in any other manner indebted to the University will be denied the recording and certification services of the Office of the Registrar, including the issuance of a transcript or diploma, and may be denied readmission until all obligations are fulfilled. The Division of Enrollment Services may stop the registration – or may cancel the completed registration – of a student who has a delinquent account or debt, and may assess all attorney's fees and other reasonable collection costs (up to 50 percent) and charges necessary for the collection of any amount not paid when due. Matriculation in the University constitutes an agreement by the student to comply with all University rules, regulations and policies.

Arrangements for financial assistance from SMU must be made in advance of registration and in accordance with the application schedule of the Division of Enrollment Services – Financial Aid. A student should not expect such assistance to settle delinquent accounts.

Students who elect to register for courses outside of their school of record will pay the tuition rate of their school of record.

WITHDRAWAL FROM THE UNIVERSITY

A student who wishes to withdraw (resign) from the University before the end of a term or session must initiate a Student Petition for Withdrawal form, obtain approval from his or her academic dean and submit the form to the Division of Enrollment Services – University Registrar. The effective date of the withdrawal is the date on which the Student Petition for Withdrawal is processed in the Registrar's Office. Discontinuance of class attendance or notification to the instructors of intention to withdraw does not constitute an official withdrawal.

Reduction of tuition and fees is based on the schedule listed in the *Financial Information: Southern Methodist University* and is determined by the effective date of the withdrawal. The schedule may be found at smu.edu/bursar, or call 214-768-3417.

Please note, however, for students receiving financial aid (scholarships, grants or loans), when the withdrawal date qualifies for reduction of tuition and fees charges, the refund typically will be used to repay the student aid programs first and go to the student/family last. Further, government regulations may require that SMU return aid funds whether or not the University must reduce its tuition and fees; hence, a student whose account was paid in full prior to withdrawal may owe a significant amount at withdrawal due to the required return of student aid. Therefore, students who receive any financial aid should discuss prior to withdrawal the financial implications of the withdrawal with staff of the Division of Enrollment Services.

Medical withdrawals have conditions that must be met prior to re-enrollment at SMU. Medical withdrawals must be authorized by the medical director, psychiatric director, counseling and testing director, or vice president for Student Affairs.

Students who live in University housing must obtain clearance from the Office of Residence Life and Student Housing.

GRADUATE AND PROFESSIONAL STUDENT AID

University grants, scholarships, fellowships and assistantships are awarded in the school or department in which the graduate student will enroll. Departments that offer the M.A., M.S. or Ph.D. degrees offer a significant number of tuition scholarships and teaching or research assistantships each year. For information, contact the department.

Grants and loans for Texas residents, private and federal loans, and employment programs may be available by filing the Free Application for Federal Student Aid. The FAFSA may be completed online at fafsa.gov. A personal identification number, which can be obtained at pin.ed.gov, can be used to electronically sign the application. SMU's code number is 003613.

See smu.edu/registrar for more information.

The standards herein are applicable to all students at the University and constitute the basic authority and reference for matters pertaining to University academic regulations and records management. Enrollment in the University is a declaration of acceptance of all University rules and regulations.

CONFIDENTIALITY OF EDUCATION RECORDS

The Family Educational Rights and Privacy Act of 1974 is a federal law that grants to students the right to inspect, obtain copies of, challenge and, to a degree, control the release of information contained in their education records. The act and regulations are very lengthy, and for that reason, SMU has issued guidelines that are available at the University registrar's FERPA website at smu.edu/ferpa. Policy 1.18 of the *University Policy Manual,* accessible at smu.edu/policy, also discusses this law.

In general, no personally identifiable information from a student's education record will be disclosed to any third party without written consent from the student. Several exceptions exist, including these selected examples: 1) Information defined by SMU as directory information may be released unless the student requests through Access.SMU Self-Service that it be withheld; 2) Information authorized by the student through Access.SMU Self-Service may be released to those individuals designated by the student; and 3) Information may be released to a parent or guardian if the student is declared financially dependent upon the parent or guardian as set forth in the Internal Revenue Code. For more information, visit smu.edu/ferpa.

STUDENT FILE NUMBER

A student's SMU identification number is an eight-digit number assigned by the University. The SMU ID number should be furnished on all forms when requested, as it is the primary means for identifying the student's academic records and transactions related to the records.

NAME CHANGE

A student who has a change in name must provide his or her Social Security card or the form issued by the Social Security Administration. Enrollment or records services for the student under a name different from the last enrollment cannot be accomplished without the above documents. All grade reports, transcripts and diplomas are issued only under a person's legal name as recorded by the University registrar.

MAILING ADDRESSES, TELEPHONE, E-MAIL ADDRESS AND EMERGENCY CONTACT

Each student must provide the University registrar with a current home address, telephone number and a local mailing address, as well as the name, address and telephone number of a designated emergency contact. Students enrolling at SMU authorize the University to notify their emergency contacts in the event of a situation affecting their health, safety, or physical or mental well-being, and to provide these contacts with information related to the situation.

Students are expected to keep current all their addresses and telephone numbers, including emergency contact details, through Access.SMU, the University's Web-based, self-service system. Changes should be reported on the Web form found at smu.edu/registrar. Students may be prevented from enrolling if their information is insufficient or not current.

The University issues all students an e-mail address. Students may have other e-mail addresses, but the University-assigned e-mail address is the official address for University electronic correspondence, including related communications with faculty members and academic units (except for distance education students).

Official University correspondence may be sent to students' mailing addresses or SMU e-mail addresses on file. It is the responsibility of students to keep all their addresses current and to regularly check communications sent to them, as they are responsible for complying with requests, deadlines and other requirements sent to any of their mailing addresses on file or to their SMU e-mail.

CELL PHONES

The University requests that students provide cellular telephone numbers, as they are one means of communicating with students during an emergency. Cellular telephone numbers may also be used by University officials conducting routine business. Students who live in University housing must obtain clearance from the Office of Housing. Students who do not have cellular telephones or do not wish to report the numbers may declare this information in lieu of providing cellular telephone numbers. However, students may be prevented from enrolling if their cellular telephone numbers are not on file or if they have not declared "no cellular telephone" or "do not wish to report cellular number."

TRANSCRIPT SERVICE*

A transcript is an official document of the permanent academic record maintained by the University registrar. The permanent academic record includes all SMU courses attempted, all grades assigned, degrees received and a summary of transfer hours accepted. Official transcripts and certifications of student academic records are issued by the University registrar for all students of the University. Copies of high school records and transfer transcripts from other schools must be requested from the institutions where the coursework was taken.

Transcripts are $11.25 per copy. Additional copies in the same request mailed to the same address are $3 per copy. Additional copies mailed to different addresses are $11.25 per copy. Requests may be delayed due to outstanding financial or other obligations or for posting of a grade change, an earned degree or term grades.

Transcripts should be requested online at smu.edu/registrar. Once on the registrar's page, click on Transcript Requests and follow the instructions. Requests will be processed through the National Student Clearing House. Telephone and e-mail requests are not accepted. Students may pick up their transcripts in person at the Registrar's Office service counter, 101 Blanton Building. No partial or incomplete transcripts including only certain courses or grades are issued. **Transcripts cannot be released unless the student has satisfied all financial and other obligations to the University.**

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* *Chapter 675, S.B. 302. Acts of the 61st Texas Legislature, 1969 Regular Session, provides:*

Section I. No person may buy, sell, create, duplicate, alter, give or obtain; or attempt to buy, sell, create, duplicate, alter, give or obtain a diploma, certificate, academic record, certificate of enrollment or other instrument which purports to signify merit or achievement conferred by an institution of education in this state with the intent to use fraudulently such document or to allow the fraudulent use of such document.

Section II. A person who violates this act or who aids another in violating this act is guilty of a misdemeanor and upon conviction is punishable by a fine of not more than $1,000 and/or confinement in the county jail for a period not to exceed one year.

SMU is permitted, but not required, to disclose to parents of a student the information contained in the education records of the student if the student is a dependent as defined in the Internal Revenue Code.

Transcripts may be released to a third party as specified by the student on the Student's Consent for SMU to Release Information to Student's Specified Third Party Form accessible at smu.edu/registrar/ferpa/forms.asp.

ENROLLMENT

The fall, spring and summer terms each have an enrollment period during which the formal process of enrollment in the University is completed. Prior to each enrollment period, the University registrar will publish enrollment instructions.

STOP ENROLLMENT/ADMINISTRATIVE WITHDRAWAL

Insufficient or improper information given by the student on any admission or enrollment form, or academic deficiencies, disciplinary actions and financial obligations to the University, can constitute cause for the student to be determined ineligible to enroll or to be administratively withdrawn.

TERM-HOUR LOADS

The unit of measure for the valuation of courses is the term hour; *i.e.,* one lecture hour or three laboratory hours per week for a term of approximately 16 weeks (including final examinations).

Enrollment for nine hours of coursework per term is recognized as a full load for persons engaged in graduate studies. In some departmental fields, exceptionally able students may complete all requirements for the Master's degree during a single academic year, but ordinarily additional work in a summer session is necessary, and in some fields, one and a half or two full academic years of work are required. After completion of the required credit-hour requirements, all Ph.D. students should retain their student status until graduation, unless granted a leave of absence. Persons who enroll for fewer than these minimum hours are designated part-time students.

A graduate student working on the completion of a thesis, dissertation or performance recital requirement on a full-time or part-time basis; enrolled in an internship or co-op program; enrolled as a third-year theater major working on the completion of required production projects; or having an instructor appointment as part of a teaching fellowship, but not enrolled for the required number of hours; may be certified as a full-time or part-time student if the student is enrolled officially for at least one course and is recognized by his or her academic dean or the dean for Research and Graduate Studies as working on the completion of the thesis, dissertation or internship requirement on a full-time or part-time basis. In other special situations, a student not enrolled for the required number of hours may be certified as a full-time or part-time student if the student is officially enrolled for at least one course, is recognized by the academic dean as a full-time or part-time student, and such recognition is approved by the provost.

CONCURRENT ENROLLMENT

A student who wishes to enroll concurrently in another college or university should first obtain written approval from the Graduate Dean's Office that the courses taken will be transferable.

INTERPRETATION OF COURSE NUMBERS

Each SMU course has a four-digit course number. The first number indicates the general level of the course: 1 – first year; 2 – sophomore; 3 – junior; 4 – senior;

5 – senior or graduate; 6, 7, 8, 9 – graduate. The second digit specifies the number of credit hours ("0" for this digit denotes no credit, one-half hour of credit, or 10–15 hours of credit; for theology courses, a "1" denotes one or one and one-half hours of credit.) The third and fourth digits are used to make the course number unique within the department.

APPROVED COURSES

Normally all graduate-level courses are numbered 6000 and above. Graduate students may take courses numbered below 6000 if it is part of the program of study or with the approval of the faculty adviser. For the 6000 level or above, the general prerequisite, in addition to admission to graduate studies, is 12 term hours of advanced work in the department, or six term hours in the department and six in a closely related program approved by the major department and the dean for Research and Graduate Studies. If other specific prerequisites are needed, these are stated in departmental listings of courses.

READMISSION AND SCHEDULE CHANGES

Students already matriculated into a program who were not enrolled in the previous term must file a readmission application. This form must be received in the graduate office **no later than three weeks before the enrollment date** for the desired term of re-entrance.

The deadline for adding courses, dropping courses without grade record and changing sections for each enrollment period is listed in the University calendar. Schedule-change forms are initiated in the office of the student's academic dean or adviser and must be completed for all courses added or dropped and for all section changes. A student may drop a course with a grade of *WP* (Withdrawal Passing) through the deadline listed in the University calendar. After the deadline, the student may not drop a class. **All schedule changes must be processed by the deadline date specified in the University calendar. Schedule changes are not complete for official University record purposes unless finalized in the Office of the University Registrar.**

AUDIT ENROLLMENT (COURSE VISITOR)

Students desiring to audit (visit) a class, whether or not concurrently enrolled for regular coursework, are required to process an Audit Enrollment Request form. Forms are available on the Web at smu.edu/registrar. Space must be available in the class. The following regulations are applicable:

1. Classroom recitation and participation are restricted; availability of course handouts, tests and other materials is restricted; no grade is assigned and no credit is recorded; no laboratory privileges are included.
2. If credit is desired, the course must be enrolled for and repeated as a regular course, and the regular tuition must be paid.
3. The student's name does not appear on class rosters or grade rosters.
4. Regular admission and enrollment procedures are not conducted for auditors.
5. The audit fee is nonrefundable. Undergraduate students enrolled for 12 or more hours may audit one three-hour course at no charge.

ENROLLMENT FOR NO CREDIT

Enrollment for "no credit" is accomplished in the conventional manner of enrollment, with regular admission and enrollment procedures being required. The student pays the regular tuition and fees, participates in class activities, is listed on class rolls and receives the grade of *NC* upon completion of the coursework.

The student must indicate in writing no later than the 12th day of classes (the fourth day during summer sessions) that he or she wishes to take a course for no credit. Permission of the instructor or department is required for this type of enrollment. This enrollment is different from *audit* enrollments, for which no enrollment or grade is recorded.

WITHDRAWAL

A student who wishes to withdraw (resign) from the University before the end of a term or session must initiate a Student Petition for Withdrawal form, obtain approval from his or her academic dean and submit the form to the Division of Enrollment Services – University Registrar. The effective date of the withdrawal is the date on which the Student Petition for Withdrawal is processed in the Registrar's Office. Discontinuance of class attendance or notification to the instructors of intention to withdraw does not constitute an official withdrawal.

Reduction of tuition and fees is based on the schedule listed in the publication *Financial Information: Southern Methodist University,* which is found at smu.edu/bursar, and is determined by the effective date of the withdrawal. This information is also available online at smu.edu/registrar. Students receiving financial aid should refer to the Financial Information section of the catalog.

The enrollment of students who withdraw on or before the fifth day of regular classes as listed in the University calendar will be canceled. Courses and grades are not recorded for canceled enrollments. A student who withdraws after the fifth class day will receive the grade of *W* in each course in which enrolled.

Medical withdrawals provide a daily pro rata refund of tuition and fees, and have conditions that must be met prior to re-enrollment at SMU. Medical withdrawals must be authorized by the medical director; psychiatric director; counseling and testing director; dean of Student Life, or vice president for Student Affairs. Authorization must be obtained no later than the University's withdrawal date for the term.

Students who live in University housing must obtain clearance from the Office of Housing.

PROBATION, SUSPENSION AND DISMISSAL

Failure to meet established minimum acceptable standards of academic or disciplinary performance can result in probation, suspension or dismissal. Information regarding disciplinary action may be found in the University Life and Services section of the catalog.

Graduate students must maintain a cumulative grade point average of 3.0. If in any term the student falls below this GPA, the student will be placed on probation for one term. If at the end of the term of probation the cumulative GPA is not up to 3.0, the student will be removed from the program.

Academic Probation. The status of academic probation is a stern warning to the student that satisfactory progress toward graduation is not being made. A student on probation is considered in "good standing" for certification purposes and is eligible to enroll. No entry is made on the permanent academic record.

Academic Suspension and Dismissal. These are involuntary separations of the student from the SMU school of record. Suspension is for a set period of time. Dismissal is permanent. A student is not in good standing in the suspending or dismissing school and is not eligible to enroll as a student in that school during the suspension or dismissal period. "Academic Suspension (or Dismissal)" is recorded on the permanent academic record.

GRADES

The grade of a student in any course is determined by the instructor of the course. The following grades are authorized for recording on the student's official graduate academic record maintained by the University registrar.

Graduate and Master of Laws Students

Grades	*Description*	*Grade Point per Term Hour*
A, A-	Excellent Scholarship	4.0, 3.7
B+, B, B-	Good Scholarship	3.3, 3.0, 2.7
C+, C, C-	Fair Scholarship	2.3, 2.0, 1.7
D+, D, D-	Poor Scholarship	1.3, 1.0, 0.7
F	Fail	0.0
P, CR	Pass, Credit	*
I	Incomplete	*
NC	No Credit Received	*
WP/W	Withdrawal Passing	*
X	No Grade Received in Registrar's Office	*

* *Grades not included in GPA*

A student may receive a grade of *I* (Incomplete) if the majority of the course requirements have been completed with passing grades but for some justifiable reason, acceptable to the instructor, the student has been unable to complete the full requirements of the course. At the time a grade of *I* is given, the instructor must stipulate in writing to the student and to the University Registrar the requirements and completion date that are to be met and the grade that will be given if the requirements are not met by the completion date. The maximum period of time allowed to clear the Incomplete grade is 12 months. If the Incomplete grade is not cleared by the date set by the instructor or by the end of the 12-month deadline, the grade of *I* will be changed to the grade provided by the instructor at the time the Incomplete was assigned or to a grade of *F* if no alternate grade was provided. The grade of *I* is not given in lieu of a grade of *F* or *W*, or other grade, each of which is prescribed for other specific circumstances. If the student's work is incomplete and the quality has not been passing, a grade of *F* will be given. The grade of *I* does not authorize a student to attend the course during a later term. Graduation candidates must clear all Incompletes prior to the deadline in the University calendar, which may allow less time than 12 months. Failure to do so can result in removal from the degree candidacy list and/or conversion of the grade of *I* to the grade indicated by the instructor at the time the grade of *I* was given.

A failure is graded F. After such a grade, credit may be obtained only by repeating the course.

The grade of *D* represents performance below average expectations. Students receiving a grade of *D* in a course that is a prerequisite to another course should consult with their adviser about repeating the course so they will be adequately prepared for work in the following course.

The grade of *W* cannot be recorded unless completion of official drop or withdrawal process has occurred by the applicable deadline **during the term of enrollment.** Only the grade of *W* may be recorded if the student has officially dropped courses from the schedule or withdrawn (resigned) from the University. The grade of *W* may not be revoked or changed to another grade, as the act of officially dropping/withdrawing is irrevocable.

The student's grades are available to the student through Access.SMU.

Grade Point Average

This average is computed by multiplying the term hours of each course attempted by the grade points earned in the particular course and then dividing the total number of grade points by the total number of hours attempted, excluding those hours for which grades are shown with an asterisk.

Pass/Fail Option

Grades of *P* or *F* may be given for graduate-level readings, research and dissertation courses at the 7000 and 8000 level, with the faculty member's decision concerning use of the option to be stated at the first meeting between the student and the faculty member. Students enrolled in dissertation courses may receive a grade of *S* for satisfactory progress pending completion of the dissertation.

Grade of Incomplete

A grade of *I* (Incomplete) indicates that work is satisfactory, but, due to reasons beyond the student's control, some portion of the required work has been left incomplete. The instructor assigning the grade of *I* stipulates to the student in writing, at the time the grade is given, the conditions under which the grade of *I* may be removed. Forms for this are available from the office of the dean. Forms for changing the grade of *I* are initiated by the course instructor and authorized by the dean for Research and Graduate Studies.

For graduate students, a maximum of two (six hours) concurrently held grades of *I* in courses other than thesis or dissertation is allowed. If this maximum is reached, the student will be allowed to take only one three-hour course per term until the Incomplete total is reduced. Students who accumulate a total of three grades of *I* in courses other than thesis or dissertation will be put on probation and not allowed to enroll further until the total is reduced.

Changes of Grades

Changes of grades, including change of the grade of *I,* are initiated by the course instructor and authorized by the academic chair and by the academic dean of the school in which the course was offered. If a student requests a grade change, the instructor may ask the student to provide a written petition requesting the change of grade, which may become an official part of any further process at the instructor's discretion. Changes of grades may be made only for the following authorized reasons: to clear a grade of *I,* to correct a processing error or to reflect a reevaluation of the student's original work. A change of grade will not be based on additional work options beyond those originally made available to the entire class.

Changes of grades of *I* should be processed within a calendar year of the original grade assignment. Other changes in grade must be processed by the end of the next regular term. No grade will be changed after 12 months or after a student's graduation except a grade successfully appealed, provided that written notice of appeal is given within six months following graduation, and in extenuating circumstances authorized by the academic dean and approved by the registrar.

Grades for Repeated Courses

Students who enter the University directly from high school may repeat up to three courses for which grades of *D+* or lower were received, provided these courses were completed before or during a student's first two consecutive regular terms following matriculation (regardless of the student's enrollment or withdrawal). "College prep" courses completed a summer prior to matriculation are NOT eligible to be repeated under this rule. The grade from the repeated course, even if lower, will be the grade used to calculate the student's grade point average. A course may be repeated only once under this policy, and it must be repeated

within the next two regular terms (regardless of the student's terms of enrollment or withdrawal, but not counting a term of academic suspension) following the term in which the course was initially taken. Exceptions to the two-term restriction may be requested from the University registrar if the course is not taught again within that period. The student must declare which courses he or she will repeat under this policy with his or her academic dean by the 12th day of classes. Only the repeated course and not the initial credit hours count toward the number needed for graduation. Both the initial and the second grades are shown on the student's permanent academic record. Students are cautioned that for some purposes, such as admission into an academic program, both grades may be used.

In all other cases, students will be allowed to repeat courses according to the following rules: Both the initial and the second grades will be on the student's permanent academic record. Both grades will be included in the calculation of the grade point average and in the determination of academic probation, suspension, honors and graduation. Only the repeated course and not the initial credit hours count toward the number needed for graduation.

The courses a student can repeat are determined by the school of record:

Dedman College and the Cox School of Business. Students can only repeat courses in which the original grade was a *D+* or below.

Meadows School of the Arts and Lyle School of Engineering. Students can repeat courses in which the original grade was a *C-* or below. Such courses can be repeated only once.

Appeal of Grades

A student who feels that an assigned grade is other than the grade earned must first discuss the matter with the course instructor to determine if the discrepancy is caused by error or misunderstanding. At the time of the initial discussion, the student may be asked to provide a written petition requesting the change of grade.

A student who is not satisfied by the instructor's denial of a request for a grade change, and who maintains that the original grade was capriciously or unfairly determined, may appeal to the chair of the department in which the course was offered (or, in the case of a nondepartmental course, to a faculty agent designated by the dean for the course). After discussing the matter with the student, and bearing in mind that the final authority in matters of academic judgment in the determination of a grade rests with the course instructor, the chair (or faculty agent) will consult with the course instructor, who will subsequently report to the student the disposition of the appeal.

A student who is not satisfied by the disposition of the appeal may appeal the decision to the dean for the course. The dean will take action as he or she deems appropriate. A student may appeal the dean's decision to the provost. In their actions, the dean and the provost must respect the principle that the determination of a grade rests with the course instructor.

THESIS/PRAXIS/DISSERTATION

Several Master's degree programs require theses for completion; several others leave theses as an option. The Doctor of Engineering program requires the completion of a praxis. Dissertation is required of all Ph.D. programs.

A final copy of the thesis/praxis/dissertation will be electronically submitted as partial fulfillment for degree requirements. A microfilm copy will be housed in the University's library and can be copied and made available to the University community, and to other individuals and institutions upon request, all at the discretion of the Central University librarian at Southern Methodist University.

GRADUATE RESIDENCE ACCOMMODATIONS

The Department of Residence Life and Student Housing operates two apartment residence halls designated primarily for graduate students.

Martin Hall, an efficiency apartment hall, houses single and married graduate students, and married undergraduate students.

Hawk Hall, a one-bedroom-apartment facility, houses married students (graduate and undergraduate) with families. Families with no more than two children may be housed in Hawk Hall. Also located in Hawk Hall is the SMU Preschool and Child Care Center.

Special Housing Needs

Students having special housing needs because of a disability should contact the Department of Residence Life and Student Housing prior to submitting the housing application. Whenever possible, the housing staff will work with that student in adapting the facility to meet special needs.

General Housing Information

Each apartment is equipped with a telephone, local telephone service, voice mail system and Ethernet connections to the University's computer system. All residence halls are air-conditioned and some have individually climate-controlled rooms. Washing machines and dryers are located in all residence halls. Meal plans are not required in graduate halls.

Applications for Residence

New graduate students should submit the completed application and contract to the Department of Residence Life and Student Housing with a check or money order for $100 made payable to Southern Methodist University for the nonrefundable housing deposit.

Priority of assignment is based on the date on which applications are received by the Department of Residence Life and Student Housing. Notification of assignment will be made by Residence Life and Student Housing. Rooms are contracted for the full academic year (fall and spring terms). Rent for the fall term will be billed and is payable in advance for students who register before August 1, and rent for the spring term will be billed and is payable in advance for students who register before December 1. Students who enroll after these dates must pay at the time of enrollment. Rent for the full academic year will be due and payable should a student move from the residence hall at any time during the school year. Accommodations for shorter periods are available only by special arrangement with the executive director of Residence Life and Student Housing before acceptance of the housing contract.

For more information, please visit the website at smu.edu/housing or contact the department: Department of Housing and Residence Life, Southern Methodist University, PO Box 750215, Dallas TX 75275-0215; phone 214-768-2407; fax: 214-768-4005; housing@smu.edu.

RECREATIONAL SPORTS

Dedman Center for Lifetime Sports

Dedman Center for Lifetime Sports (smu.edu/recsports) is a facility designed for recreational sports and wellness. The 170,000-square-foot expansion and renovation was completed in 2006. The center provides racquetball courts; aerobic studios; indoor running track; basketball; indoor and outdoor sand volleyball courts; climbing wall; bouldering wall; 25-meter, five-lane recreational pool; 15,000 square feet of fitness and weight equipment; lobby; and café. Various fitness classes are offered. These facilities are open to SMU students, faculty, staff and members.

Intramurals

Many opportunities for team and individual competition are available through intramurals. Various leagues provide year-round opportunities to participate in a wide variety of activities. The five major sports are football, volleyball, basketball, soccer and softball. Other sports and activities offered are bowling, golf, racquetball, tennis, track, swimming and game room activities. Additional leadership opportunities are available for those interested in officiating or supervising various activities.

Sport Clubs

Sport clubs offer an opportunity for students interested in concentrated training and participation in a sport who do not want to train and devote the practice time required for NCAA competition. These student-sanctioned clubs, funded by the Student Senate, offer competition with other university/college club teams in baseball, badminton, cricket, crew, cycling, ice hockey, men's and women's lacrosse, martial arts, rugby, sailing, soccer, triathlon, volleyball, and wakeboarding.

Aquatics

SMU Aquatics features a five-lane, indoor recreational pool and outdoor, zero-depth entry fountain pool known as "The Falls." Students have opportunities to participate year-round in recreational swimming, sunbathing and competitive water sports such as water basketball, volleyball and polo. Classes offered include water fitness, adult and child swimming lessons, children's group lessons, and American Red Cross Lifeguard and Water Safety Instructor certifications. Both pools also are available for student group reservations.

Fitness

SMU Fitness offers group exercise classes, personal training sessions and massage therapy. The group exercise (Group X) classes are offered throughout the day to accommodate early birds, night owls and everyone in between. A plethora of different types of cardio, strength and flexibility classes are available. Experienced and knowledgeable trainers offer sessions to train clients, either one-on-one or in groups, to meet their personal fitness goals. Licensed massage therapists offer chair or full-body massages. All SMU Fitness programs have a fee for participation.

Outdoor Adventures

Outdoor Adventures comprises Outdoor Recreation (outdoor trips), The Rental Shop (renting outdoor equipment), SMU Climbing Center (climbing wall and bouldering wall), and Challenge and Team-Building Activities (incorporating a portable challenge course). SMU OA offers fun and challenging outdoor recreation activities, community-building programs and leadership opportunities through backpacking, rock climbing, kayaking, canoeing and more.

Mustang Band

Founded in 1917, the Mustang Band was named the "Best College Marching Band" in Texas in Kirk Dooley's *Book of Texas Bests.* Long known as "the hub of SMU spirit," the band represents the University at football and basketball games, produces the *Pigskin Revue* during homecoming and performs at special University- and community-related events. Membership is open to all SMU students by audition, regardless of major, and scholarships based on need and ability are available.

Spirit Squads

The Cheerleading Squad, Pom-Pom Squads and Peruna mascot are integral parts of SMU's spirit tradition and are national award winners, having participated in the NCA/NDA Collegiate National Championships. Along with the Mustang Band, they make SMU's spirit contingent a superb one.

HEALTH SERVICES

SMU Memorial Health Center

The University's health facilities are located in the SMU Memorial Health Center, 6211 Bishop Boulevard. An outpatient primary care clinic, specialty clinics, pharmacy and lab/X-ray facilities occupy the first floor. Counseling and Psychiatric Services and the Office for Alcohol and Drug Abuse Prevention are located on the second floor. The Health Center (smu.edu/healthcenter) is accredited by the Accreditation Association for Ambulatory Health Care Inc.

Outpatient Medical Services. SMU provides a convenient, economical medical clinic for diagnosis and treatment of illness and injury, as well as for immunizations and continuation of treatment such as allergy injections. The clinic is staffed by physicians, physician's assistants, registered nurses, medical assistants, and lab and X-ray technologists. Physicians are available by appointment from 8:30 a.m. to 4 p.m., Monday through Friday. For Saturday clinics and extended hours, see the Health Center website (smu.edu/healthcenter). For appointments and health information, call 214-768-2141. After hours and during holidays, a nurse advice line is available at 214-768-2141.

Patient Observation. When ordered by a staff physician, a student may be held in observation between 8:30 a.m. and 5 p.m., Monday through Friday. Observation is available for most types of nonmajor medical treatment. When necessary, students are referred to medical or surgical specialists in Dallas. The patient will be responsible for the costs of these services.

Acute/After Hours Care. For emergency care after clinic hours, it is recommended that students call 911 or go to a hospital emergency room. Refer to the Health Center website (smu.edu/healthcenter) for hospital information and location of an urgent care facility.

Costs. Undergraduate and graduate students paying the full fee (which includes a health service fee) receive fully covered primary care physician services at the Health Center for that term. Appointments with the gynecologist or dermatologist and lab, X-ray, pharmacy and supplies costs will be charged at reasonable rates. Graduate students not paying full fees have the option to pay the Health Center fee of $140 per term or $50 per visit, not to exceed $140 per term.

Mandatory Health Insurance Policy. To ensure that students have appropriate health care coverage, SMU requires its students to maintain insurance as a condition of enrollment. All international students enrolled in one or more credit hours are required not only to maintain coverage, but their coverage must be in the SMU Student Insurance Plan. International students may apply for a waiver if: 1) the student is covered by a comparable embassy plan or 2) the student can provide documented evidence of comparable health insurance coverage by a U.S. employer, including medical evacuation and repatriation. All domestic students taking at least nine credit hours are required to: 1) provide proof of comparable U.S. health coverage or 2) enroll in the SMU Student Insurance Plan. All students may view the plan benefits, waive coverage and/or enroll online at ahpcare.com/smu, or call Academic Health Plans at 888-308-7320 for further details. A student must be enrolled in at least one credit hour to qualify for the SMU Student Health Plan. Insurance packets are also available at the Health Center. Domestic students who have other insurance will be provided an itemized receipt upon request at the time of service. This receipt is adequate to file with insurance companies for reimbursement. Health insurance is separate from the student health-center fees and is paid for independently.

Pharmacy. A complete pharmacy with registered pharmacists is open from 8:30 a.m. to 5 p.m., Monday through Friday. Many prescription plans are accepted.

X-ray and Laboratory Services. X-ray and laboratory tests are available for nominal fees. All X-rays are interpreted by a radiologist.

Immunizations. All students are required to have an SMU medical history form on file in the SMU Health Center before registration. To comply with SMU policy, all students must provide proof of immunizations against measles, rubeola (red or regular measles), and rubella (German or three day measles). These immunizations must be documented by a physician, public health record or school health record. Students will not be allowed to register without compliance. Students are encouraged to check their Access.SMU account for health forms and immunization status. Immunizations are available at the Health Center.

Class Absence Due to Illness. Students should schedule appointments with physicians at times when classes will not be missed. The Health Center does not issue excuses from classes for illness. Refer to the Health Center website (smu.edu/healthcenter) for the Class Absence Policy.

Notification of Parents. Students are encouraged to call one or both parents when ill. Parents or guardians will be notified in cases of life threatening illnesses. The Health Center staff may not speak to parents without the student's permission.

Health Service Records. All health service records are confidential. A copy of medical records may be released to a physician only with a written release by the student. Records are not made available to parents, SMU administrators, faculty or staff without the student's written consent.

Counseling and Testing Services

Counseling and Psychiatric Services. CAPS provides psychiatric evaluation, crisis intervention and group/individual/couples psychotherapy for students. All interviews are conducted on a voluntary and confidential basis. There is no charge to students who have paid the University health fee. Students can seek confidential help for concerns such as anxiety, depression, relationship issues, career/life planning, learning disabilities, sexual identity, eating/body image concerns and sexual assault/sexual harassment matters. Any laboratory tests or pharmaceuticals ordered will be charged to the student. Appointments may be scheduled between 8:30 a.m. and 5 p.m., Monday through Friday, by calling 214-768-2877.

Testing Services. Testing Services offers testing to the Dallas-area community. These services include on-campus administration of national testing programs such as the SAT, LSAT, GRE Subject and PRAXIS. Other testing offered includes CLEP tests and correspondence examinations for other universities. For additional information, call the center at 214-768-2269.

Office for Alcohol and Drug Abuse Prevention. This office provides a free and confidential source of help and information to the SMU community on issues related to substance abuse and addiction. Appointments for counseling or assessment can be made between 8:30 a.m. and 5 p.m., Monday through Friday, by calling 214-768-4021. For more information, visit smu.edu/liveresponsibly.

Office of Health Education and Promotion. This office serves as a resource for health information on campus. The office promotes programs and activities that focus attention on health-related issues affecting college students. Students can get involved with health education on campus through the Peer Advising Network. For more information, visit smu.edu/healthcenter/healtheducation or call 214-768-2393.

SMU PRESCHOOL AND CHILD CARE CENTER

The SMU Preschool and Child Care Center is a fully licensed center open throughout the year to students, faculty and staff. Children ages 1 month through 5 years are accepted, subject to space availability. Hours of operation are 7:45 a.m.

to 5:30 p.m. Fees are adjusted to the age of the child. For more information, please contact the center: Director, SMU Preschool and Child Care Center, Southern Methodist University, Dallas TX 75275; 214-768-2278.

ACADEMIC INTEGRITY AND CODE OF CONDUCT

The Honor Code of Southern Methodist University

Intellectual integrity and academic honesty are fundamental to the processes of learning and of evaluating academic performance, and maintaining them is the responsibility of all members of an educational institution. The inculcation of personal standards of honesty and integrity is a goal of education in all the disciplines of the University.

The faculty has the responsibility of encouraging and maintaining an atmosphere of academic honesty by being certain that students are aware of the value of it, that they understand the regulations defining it and that they know the penalties for departing from it. The faculty should, as far as is reasonably possible, assist students in avoiding the temptation to cheat. Faculty members must be aware that permitting dishonesty is not open to personal choice. A professor or instructor who is unwilling to act upon offenses is an accessory with the student offender in deteriorating the integrity of the University.

Students must share the responsibility for creating and maintaining an atmosphere of honesty and integrity. Students should be aware that personal experience in completing assigned work is essential to learning. Permitting others to prepare their work, using published or unpublished summaries as a substitute for studying required material, or giving or receiving unauthorized assistance in the preparation of work to be submitted are directly contrary to the honest process of learning.

Students who are aware that others in a course are cheating or otherwise acting dishonestly have the responsibility to inform the professor and/or bring an accusation to the Honor Council.

Students and faculty members must share the knowledge that any dishonest practices permitted will make it more difficult for the honest students to be evaluated and graded fairly and will damage the integrity of the whole University. Students should recognize that both their own interest and their integrity as individuals would suffer if they condone dishonesty in others.

The Honor System

All students at SMU are subject to the jurisdiction of the Honor Code and as such will be required to sign a pledge to uphold the Honor Code (smu.edu/studentlife). The Honor Council is composed of a minimum of 27 members selected through an application and interview process organized by the Honor Council Executive Board. Five faculty members will be nominated by the Faculty Senate. The council's responsibility is to maintain and promote academic honesty.

Academic dishonesty includes plagiarism, cheating, academic sabotage, facilitating academic dishonesty and fabrication. Plagiarism is prohibited in all papers, projects, take-home exams or any other assignments in which the student submits another's work as being his or her own. Cheating is defined as intentionally using or attempting to use unauthorized materials, information or study aids in any academic exercise. Academic sabotage is defined as intentionally taking any action that negatively affects the academic work of another student. Facilitating academic dishonesty is defined as intentionally or knowingly helping or attempting to help another to violate any provision of the Honor Code. Fabrication is defined as intentional and unauthorized falsification or invention of any information or citation in an academic exercise.

Suspected cases of academic dishonesty may be handled administratively by the appropriate faculty member in whose class the alleged infraction occurred or may be referred to the Honor Council for resolution. Suspected violations reported to the Honor Council by a student or by an instructor will be investigated and, if the evidence warrants, a hearing will be held by a board composed of a quorum of four members of the Honor Council.

Any appeal of an action taken by the Honor Council shall be submitted to the University Conduct Council in writing no later than four calendar days (excluding school holidays) after notification of the Honor Council's decision.

Code of Conduct

The following are University procedures and standards with which every student must become familiar. The University considers matriculation at SMU an implicit covenant and a declaration of acceptance on the part of the student of all University regulations. The Student Conduct and Community Standards Office (smu.edu/studentconduct), part of the Office of the Dean of Student Life, assists students in their personal development by providing a fair conduct process that issues consistent sanctions for behavior that is incongruent with the University's expectations for students.

Conduct. Standards of conduct are established through faculty, student and administrative efforts and are under continuous evaluation by the entire University community in order to assure reasonable and fair limits. At SMU, the student is assumed to have a high degree of loyalty and responsibility to the University and its well-being, as well as to himself or herself in personal, social and intellectual pursuits; the student's behavior both on and off campus is evidence of this.

Students at SMU will discover that they are encouraged to exercise a great amount of personal freedom as well as accompanying responsibilities. Through their personal capacities for intelligent thought and action, mature students understand that there are situations in which certain behavior must be modified for the benefit of others. The University stands firm in its commitments to the rights and freedoms of students, expecting in return the same respect and concern.

The University expects all students to be responsible citizens and to abide by all federal, state and local laws. Personal irresponsibility – including, but not limited to, that evidenced by dishonesty, gambling, hazing, irresponsible conduct, and the misuse of drugs and alcohol – renders a student subject to disciplinary action. Although most specific regulations pertain to a student's behavior while on campus, a lack of personal responsibility and integrity is always considered grounds for discipline no matter where it occurs. Due respect for the entire University community, faculty, staff and one's fellow students is always expected.

Students are required to identify themselves when asked by a properly identified faculty or staff member, or by another student serving as a University staff member. Persons who are not members of the University community and without business on campus may be asked to leave.

Disciplinary Action. Clear disciplinary procedures are an important part of the mission of SMU as an educational institution. The intent of the system of due process at SMU is to be educational and not merely punitive for students. The goal continues to be to produce quality citizens. It is pertinent to the purpose of discipline to remember that self-discipline is part of the entire educational process, whereby the student becomes more fully aware of the importance of responsibility for oneself and others. Anytime a student displays irresponsible behavior, that student will be subject to discipline.

Depending on the degree of misconduct, a student may be subject to sanctions ranging from a conduct reprimand to expulsion from the University. Should a student be asked to leave the University, he or she should do so in an expeditious and peaceful manner. The student should remain off campus until he or she receives written permission from the Office of the Dean of Student Life to return to campus. In the event of such separation, a student is still responsible for University financial obligations.

The University believes in student representation on all disciplinary bodies. To ensure fairness and due process for all students in the conduct process, the student is granted an impartial hearing and the right to appeal to the University Conduct Council. A student who is appealing a sanction may remain in school until the decision and penalty are reviewed, unless considered harmful to the University, to any individual, or to himself or herself. All actions by the council are subject to presidential review.

Having voluntarily enrolled as students at Southern Methodist University and assumed a place in the University community, all students are presumed to be knowledgeable of, and have agreed to abide by, the rules and regulations set forth in the Student Code of Conduct, as outlined in the *SMU Student Handbook*. This book is available from the Office of the Dean of Student Life: Hughes-Trigg Student Center, third floor; smu.edu/studentlife.

Loss of Personal Property. The University is not responsible for the loss of personal property belonging to students in any building or on any grounds owned by the University, whether the loss results from theft, fire or unknown cause.

SERVICES FOR STUDENTS WITH DISABILITIES

The Office of Services for Students with Disabilities strives to support the educational, career, social and recreational choices of SMU students with documented disabilities through coordination of services and reasonable accommodations. It is the responsibility of the students themselves to establish eligibility for services or accommodations through this office. They must provide: 1) appropriate current documentation in keeping with SMU's documentation guidelines and 2) a request indicating what kind of assistance is being sought, along with contact information.

Documentation takes one to two weeks to be reviewed. Students with disabilities are encouraged to contact the office at 214-768-4557 to learn what opportunities and services are available. It is recommended that contact be made as early as possible so students can establish their eligibility for services in a timely fashion and take full advantage of services for which they may be eligible. For more information, please visit the website at smu.edu/OSSD.

SMU LIBRARIES

Service to Southern Methodist University students, faculty and staff is the primary goal of all libraries at SMU. The libraries of the University contain more than 2.9 million volumes. PONI, a fully interactive Web- and Windows-based client-server system, features access to bibliographic records of materials housed in all SMU libraries and hypertext links to other databases, digitized collections and relevant websites.

SMU libraries rank first in total volumes held among non-ARL (Association of Research Libraries) universities in the United States. The SMU libraries comprise the largest private research library in the Southwest and rank third within the region in total volumes, after the University of Texas at Austin and Texas A&M University. SMU libraries are one of the greatest assets of the University.

The University's library system is divided into a number of different units:

1. Central University Libraries (reporting to the Office of the Provost).
2. Underwood Law Library (reporting to the Dedman School of Law).
3. Bridwell Library (reporting to the Perkins School of Theology).
4. Business Information Center (reporting to the Cox School of Business).

The Business Information Center

The Business Information Center is located in room 150 of the Maguire Building. The mission of the BIC is to provide the SMU community with business information, regardless of format; support the integration of information and technology into the curriculum; and act as a center for research and development for state-of-the-art information technology applications in the business education field. In support of this mission, the BIC offers the SMU community both quiet and group study areas; individual and group computer areas consisting of 70 computer workstations; a multimedia studio; a group presentation practice room; a periodicals area; facility-wide wireless access; over 150 electronic resources; and a variety of print resources, including the Hillcrest Foundation International Resource Library, the Edwin L. Cox Business Leadership Center Resource Collection, the Cary M. Maguire Energy Institute Resource Collection and the Career Management Center Library. Librarians are available all hours that the BIC is open, offering reference assistance both in-person and virtually via e-mail and telephone. Librarians provide course specific, in-class instruction at the request of instructors and lead workshops on performing business research.

Bridwell Library

Bridwell Library of the Perkins School of Theology is the University's principal research resource for the fields of theology and religious studies. It offers a collection of over 350,000 volumes and 1,200 current periodical titles and provides access to a wide array of online full-text journals and databases. Among the library's special collections are significant holdings in early printing, English and American Methodism, theology, religion, and the book arts. The interpretation of these collections is accomplished variously through lectures, publications and exhibitions. Reference librarians are available to help students discover and use the many resources of Bridwell Library.

Underwood Law Library

Underwood Law Library, one of the 30 largest law libraries in the country and the largest private law library in the Southwest, houses more than 630,000 volumes and primarily serves the faculty and students of the Dedman School of law. The collection includes state and federal legislative, judicial and administrative

materials; law periodicals; law treatises; U.S., international and foreign documents; and U.S. government documents relating to the legal profession. Strengths of the collection are in taxation, securities, corporate law, labor law, air and space law, commercial and banking law, constitutional law, and law and medicine. The Kay and Ray Hutchison Legal Resource learning Center in the Underwood Law Library is a computer-learning lab located on the third floor.

Central University Libraries

The largest of the SMU library units is Central University Libraries, with holdings of more than 2.1 million volumes. CUL comprises Fondren Library, the Hamon Arts Library, the Science and Engineering Library, the DeGolyer Library and SMU Archives, the Institute for the Study of Earth and Man Reading Room, and the Emily C. Norwick Center for Digital Services. CUL also supports SMU programs at the Legacy campus and SMU-in-Taos.

Fondren Library, with more than one million volumes of books, government publications and bound journals, serves students and faculty in the areas of humanities, social sciences, business and education. Its Information Commons provides a single location within the library where students can use library books and online resources, as well as the latest computer software and technology, to prepare their assignments. Fondren Library is a selective depository for government information resources and has large electronic collections of retrospective periodicals and special collections in the humanities and social sciences.

Strengths of the Fondren Library include, but are not limited to, classical studies, late 18th- and early 19th-century English literature, American history, Texas history, contemporary biography and literature, anthropology, political science, economics, and other social sciences. Fondren Library also provides reading materials placed on reserve by classroom faculty and access to holdings from other libraries nationwide via interlibrary loan.

Hamon Arts Library, located in the Owen Arts Center of the Meadows School of the Arts, serves students and faculty in the areas of visual art, art history, cinema, communications, dance, music and theater. With more than 180,000 volumes of books, sound recordings and video recordings, the library's collections support the Meadows curriculum and are particularly strong in European and American arts. The library also provides conference room facilities; group audio-visual study and presentation rooms; and public computers for research, study and arts-specific software projects.

The Jerry Bywaters Special Collections wing has as its focus the art and artists of the Southwest, the musical life of Dallas, regional theater history, fashion history, and regional architecture. The G. William Jones Film and Video Collection, founded in 1967, holds over 10,000 films and videos on a wide array of subjects and in all formats. The Jones Collection is best known for its Tyler, Texas, Black Film Collection and for the Sulphur Springs Collection of pre-nickelodeon films.

The Science and Engineering Library contains holdings of more than 700,000 volumes and serves students and faculty in the areas of the sciences and engineering. The Science and Engineering Library is responsible for the University's map collection, which includes more than 220,000 topographic and geologic maps and aerial photographs, and the DeGolyer Earth Sciences collection of more than 15,000 geological volumes.

CUL has a corporate research service – **IIS** – housed in the Science and Engineering Library, providing cost-recovery, fee-based information services to the business and corporate community outside the University.

DeGolyer Library is a noncirculating special collections branch of CUL that contains more than 120,000 volumes. In addition to rare books, it holds over 2 million manuscripts, 500,000 photographs, 2,500 newspaper and periodical titles, 2,000 maps, and an extensive collection of ephemera that includes the largest collection of Texas bank notes in the country. The DeGolyer Library is open to all students and faculty. Great strengths of the DeGolyer Library include a large collection of books on early voyages and travels, especially those bearing on the European discovery and exploration of the New World. The collection of Western Americana is numbered among the finest in the country, and the library has exceptionally well-developed collections in the fields of business history, such as the JCPenney archives, and transportation history, in particular the history of railroads. Its holdings in the history of science and technology, which include the Texas Instruments archives, have much to offer the researcher. Literary collections include a respectable range of English and American authors and literary genres, from a 16th-century edition of Chaucer's *Canterbury Tales* to dime novels and comic books. DeGolyer collections also afford numerous opportunities for interdisciplinary research in such fields as American studies, Southwestern studies, women's studies, popular culture, the history of photography and the history of the book.

University Archives, part of the DeGolyer library, is the official repository for SMU records and other materials of historical importance. The archives contain manuscripts, photographs, documents and memorabilia concerning the establishment and growth of the University. SMU administrators, faculty, local historians and media representatives are its principal users, but students and visiting scholars often use its materials for a variety of research projects.

The ISEM Reading Room, with 10,000 volumes, serves students and faculty of the Institute for the Study of Earth and Man. It contains a wealth of information relating to anthropology and geological and geophysical sciences.

The Norwick Center for Digital Services in CUL encompasses student multimedia and collaborative technology areas, digitization/production services, and a screening room. The Student Multimedia Center provides students with access to high-end computers, software, collaborative spaces and staff assistance to develop a variety of digital projects such as DVDs and Web video, digital portfolios, and other media-intensive projects. The Library Digital Projects Office focuses on digitizing library collections for preservation and increased access. The screening room allows for video screenings and computer projection for instruction and training.

LABORATORIES AND RESEARCH FACILITIES

The University provides many laboratories and much equipment for courses in accounting; anthropology; art; biology; chemistry; languages; Earth sciences, communication arts; psychology; physics; health and physical education; dance; music; theater; statistics; and civil, computer, electrical, environmental and mechanical engineering.

The teaching laboratories of the departments of Biological Sciences, Chemistry, Earth Sciences and Physics are housed in the **Fondren Science Building** and in the **Dedman Life Sciences Building.** Virtually all teaching laboratories and support facilities in the buildings have been remodeled and updated.

Students have access to a wide array of specialized instrumentation and laboratory equipment fundamental to studies in the natural sciences, including spectrophotometers, high-performance liquid chromatographs, scintillation counter, fluorescence-activated cell sorter, scanning laser confocal microscope, electron resonance spectrometer, X-ray diffractometers, mass spectrometers and an atomic absorption

spectrometer. Advanced undergraduate research is also supported by tissue culture and animal care facilities, as well as several departmental computer laboratories.

SMU-in-Taos, Fort Burgwin, is located 10 miles south of Taos, New Mexico, at an elevation of 7,500 feet. The facility includes classrooms, laboratories, offices, a computer center and a library, as well as living accommodations for students and faculty. The Fort Burgwin archaeology curation facility houses over one million archaeological specimens from research projects conducted by SMU faculty and students. Northern New Mexico offers a multiplicity of research opportunities for both natural and social scientists. Pot Creek Pueblo, located on the fort's property, is one of the largest prehistoric archaeological sites in the Taos region.

The N.L. Heroy Science Hall houses the departments of Anthropology, Earth Sciences, Sociology and Statistical Sciences, as well as the Institute for the Study of Earth and Man.

The Institute for the Study of Earth and Man was created in 1966 by a gift from W.B. Heroy, Sr. Its purpose is to support research at the interface of humans, Earth and the environment.

The Department of Earth Sciences operates several unique laboratories, including the following:

The Dallas Seismological Observatory, established by the Dallas Geophysical Society, is maintained and operated by the University and now monitors remote seismic and infrasound stations in southwestern Texas near Lajitas, seismically one of the world's quietest regions. The Lajitas array is used to test technology designed to detect small earthquakes from great distances. In addition to the Lajitas seismic array, SMU operates seismic and infrasound arrays at Mina, Nevada; Grenada, Mississippi; and overseas locations. Data collected by the observatory are available to the faculty and advanced students who wish to undertake basic research in seismology, tectonics or infrasound.

The Ellis W. Shuler Museum of Paleontology is a research museum affording opportunities for advanced study of fossil faunas and floras and their climatic and paleoecologic significance. The collection, which specializes in vertebrate paleontology, includes more than 150,000 fossils from the United States, Central America and northeastern Africa.

The Pollen Analysis Laboratory is operated in conjunction with the Shuler Museum of Paleontology. The laboratory serves SMU research projects focused on the reconstruction of past vegetation, past climate and paleoecology at localities around the world. The facility includes two fume hoods, glassware, centrifuges, scales, a convection oven and storage space necessary for the dry and wet processing of sediment samples for their pollen content. Microscopic analysis of the resulting pollen sample residues takes place in a separate laboratory housing transmitted light microscopes, a comparative collection of modern pollen, and a small paleobotany and palynology research library. Work in this laboratory is often supplemented by facilities in the Variable Pressure Scanning Electron Microscope Laboratory.

The Geothermal Laboratory is the focus of an extensive program of research in the thermal field of the Earth. Geothermal energy resources and the thermal fields of sedimentary basins are special topics of concentration. The research is worldwide in scope. Specialized equipment for the measurement of thermal conductivity of rocks and for the measurement of accurate, precise temperature logs in deep wells is available for research purposes. Services are provided to other institutions and research centers on a contractual basis.

The Hydrothermal Laboratory contains equipment to reproduce the pressures and temperatures existing to midcrustal depths. It contains two extraction-quench sampling bombs that permit withdrawal of solution during the progress of a run to pressures of 3 kbar and 750ºC. There are also 10 cold-seal reaction vessels. In addition, 1 atm furnaces are available that can be used to temperatures of 1400ºC.

The Electron Microprobe Laboratory contains a fully automated JEOL 733 electron microprobe with four wavelength dispersive X-ray spectrometers, a Link eXL energy dispersive X-ray and associated sample preparation equipment. It is available on a regular basis for various research projects in the Institute for the Study of Earth and Man, the University and other research institutions.

The Stable Isotope Laboratory is a general research facility available to support both academic and student research in the University and in other research centers. The laboratory contains three automated gas-source, magnetic-sector isotope ratio mass spectrometers as well as vacuum extraction lines for converting natural materials (solids, liquids and gases) into gases suitable for measuring the isotope ratios of hydrogen, carbon, nitrogen and oxygen at natural abundance.

The Variable Pressure Scanning Electron Microscope Laboratory contains a Zeiss SMT 1450 VPSE SEM used for generating electron photomicrographs with 5-nanometer resolution. The SEM Laboratory is open to researchers and students from Earth Sciences, Environmental Sciences, Engineering and Chemistry. The SEM Laboratory is also equipped with an Edax energy dispersive X-ray system for quantitative determination of chemical compositions of the imaged materials.

The X-ray Diffraction Laboratory houses a Rigaku Ultima III diffractometer for the X-ray identification of materials with a crystalline structure and is open to researchers and students from Earth Sciences, Chemistry, Environmental Sciences and Engineering.

MUSEUM

The Meadows Museum, founded by the late philanthropist Algur H. Meadows and located at 5900 Bishop Boulevard, houses one of the finest and most comprehensive collections of Spanish art outside of Spain, as well as selected masterpieces of modern European sculpture from Rodin and Maillol to David Smith and Claes Oldenburg. The permanent collection of 670 objects includes paintings, sculpture, decorative arts and works on paper, from the Middle Ages to the present. Artists represented include El Greco, Velázquez, Ribera, Zurbarán, Murillo, Goya, Picasso and Miró. The Meadows Museum hosts a regular program of loan exhibitions each year in its temporary exhibition galleries and sponsors an active program of public lectures, tours, films, concerts and symposia, as well as children's art programs and family days throughout the year. Museum collections are often utilized by SMU faculty in their courses. The museum membership program includes exhibition previews, tours of private collections and opportunities for travel. Docent tours of the collection are available to school, University and adult groups. The Meadows Museum, in addition to its collection, houses a museum store and special event rooms.

Office of Information Technology

The Office of Information Technology, located on the fourth floor of the Blanton Student Services Building, is responsible for providing computing and communications services in support of the academic and administrative functions for students, faculty, staff, alumni and patrons of the University. These services include an SMU e-mail account, access to enrollment and financial data online, Internet access both on and off campus, telephone services, Web-based services, technical support, and a variety of software and hardware discounts.

SMU offers high-speed network connections throughout campus. Students can take advantage of both wired and wireless connections throughout all areas of the residence halls. Wireless coverage also extends throughout the campus in most classrooms, libraries, common areas and several outdoor locations. In addition to on-campus Internet connections, OIT provides off-campus connections through dial-up access and virtual private networks.

All students receive an SMU e-mail account, which remains active throughout their enrollment at the University. The e-mail account may be accessed online via webmail.smu.edu. In addition, students have access to a variety of Web-based services, including Access.SMU; personal Web space; network storage space; and academic applications, including the Blackboard Course Management System. All academic information including grade history, financial information, transcripts and class registration is available through the Access.SMU system.

The OIT Help Desk provides technical support for most computing issues from 7:30 a.m. to 6:30 p.m., Monday through Thursday, and from 7:30 a.m. to 5:30 p.m. on Fridays. Both phone and in-house support is available for on- and off campus connectivity issues and computer virus issues. The Help Desk also offers phone support for the Microsoft Office Suite and other common applications.

Although most students have their own computers, there are a number of public computer labs available for use. Labs are located in each of the residence halls and throughout the campus libraries. Almost all of the labs contain both Mac and PC workstations and support a variety of programs. There is also 24-hour computer access available in the Hughes-Trigg Student Center.

The Computer Corner by HiEd, located in the Hughes-Trigg Student Center, is the on-campus computer store. It offers a number of discounts on hardware and other peripherals. Students also may take advantage of software discounts on Microsoft and Adobe applications through a campus license agreement. Computer repair service is offered on a per-charge basis.

OIT also provides on-campus telephone and voicemail services and discounts on cellular services, which students may obtain at any time throughout the year.

For additional information on services provided by OIT, visit smu.edu/help or call the Help Desk, 214-768-HELP.

HART eCENTER

Guildhall at SMU

The Guildhall at SMU is the first digital game development program to be based at a research university. The program has been accredited by the Southern Association of Colleges and Schools. It offers an 18-month program that prepares students to work in the digital games development industry. The program has three tracks: art creation, software development and level design. Students who successfully complete the program will receive a certificate from the Hart eCenter at SMU.

ENGLISH AS A SECOND LANGUAGE PROGRAM

John E. Wheeler, **Director**

Students whose first language is not English may encounter special challenges as they strive to function efficiently in the unfamiliar culture of an American university setting. The Office of General Education offers the following ESL resources to students from all schools and departments of SMU.

The Courses (ESL)

1001. ESL Communication Skills. The goal of this course is to improve ESL students' oral and aural interactive skills in speaking, giving presentations, pronunciation, listening and American idiomatic usage so they may become more participatory in their classes and integrate more readily with their native English-speaking peers. It is designed to meet the needs of both undergraduate and graduate students who may be fully competent in their field of study yet require specialized training to effectively communicate in an American classroom setting. The course is noncredit and no-fee, and is transcripted as Pass or Fail. ESL Program approval is required, and students may apply online at smu.edu/esl.

1002. ESL Communication Skills II. Building on skills developed in ESL 1001, students make use of their knowledge and practice to explore various aspects of American studies. In addition to speaking and presentation skills, reading and writing are also exploited as a means for students to gain a deeper understanding of American culture, customs, attitudes and idiomatic use of the language. The course is noncredit and no-fee, and is transcripted as Pass or Fail. ESL 1001 is recommended as a precursor but is not a prerequisite. ESL Program approval is required, and students may apply online at smu.edu/esl.

1300, 1301, 1302. ESL Rhetoric. The ESL sequence of first-year writing aims to provide students with the tools they will need to successfully complete writing assignments required of them during their University coursework. The ultimate goal of the class is to bring students' analytical reading and writing skills in line with the standards expected of their native English-speaking peers. Building on the principles of effective writing taught in regular rhetoric classes, students are given extra practice in vocabulary development, grammar skills, standard American English pronunciation and conversational fluency. The 1302 courses are specially designed around themes that are pertinent to the realities and experiences of nonnative speakers of English. ESL sections of rhetoric grant students the same amount of credit as do regular rhetoric classes, and "ESL" will not appear on the transcript. ESL Program approval is required.

20XX. Intensive English Program (IEP). All 2000-level courses are exclusive to IEP. This multilevel, yearlong program is designed to prepare students and professionals for academic success at the university level. The course of study consists of English for academic purposes, TOEFL-related skills and American culture. It is open to currently enrolled and newly incoming students, as well as to those not affiliated with SMU. On-campus housing and meals are available during the six-week summer term. This is a noncredit, nontranscripted program, and separate tuition fees will be charged. ESL Program approval is required, and the application package may be downloaded via the IEP link at smu.edu/esl.

3001. Advanced Grammar for Writers. This course helps students develop their grammar and writing skills within the context of academic readings. Problem areas of English grammar and style are explored through periodic assignments, research documentation methods

and a final research project. The course is free of charge, noncredit bearing, and will appear on the transcript as Pass or Fail. ESL Program approval is required, and students may apply online at smu.edu/esl.

3002. Advanced Academic Writing. Building on principles of grammar and style covered in ESL 3001, this course helps students further improve the writing skills needed for their particular academic careers, using academic texts as a basis for out-of-class writing assignments and a final research project. The course is free of charge, noncredit bearing, and will appear on the transcript as Pass or Fail. ESL Program approval is required, and students may apply online at smu.edu/esl.

4001. ESL Pronunciation Skills. Students improve their pronunciation by focusing on sentence stress, rhythm, intonation and body language while learning to mimic American speech patterns. With the instructor's assistance and extensive individual feedback, students develop personal strategies and exercises to become more aware of their own weaknesses. The course is free of charge, noncredit bearing, and will appear on the transcript as Pass or Fail. ESL Program approval is required, and students may apply online at smu.edu/esl.

Conversation Buddy Program

Once at the beginning of each term, all students are notified via campus e-mail of this opportunity to practice their language skills in an informal, one-on-one setting outside the classroom for one to two hours a week. Every effort is made to match native speakers of English with a native speaker of a language or culture in which they may have an interest. In this way, both the ESL student and the native English speaker benefit from a two-way language exchange. To apply for a Conversation Buddy, send an e-mail to smithjr@smu.edu.

ESL Self-Study Lab

A collection of audio- and videotapes plus computer software is available for self-study use at the Fondren Library Information Commons. Students will find materials to help them improve their pronunciation, listening, vocabulary and grammar skills.

SMU-IN-TAOS

The University maintains an academic campus at Fort Burgwin, located 10 miles southeast of Taos, New Mexico. SMU-in-Taos is open for summer study each year, offering courses in the humanities, natural and social sciences, business, and performing and studio arts, as well as archaeological research. The campus plans a full fall term beginning in 2009.

Students are housed in small residences called *casitas*. Each residence has separate dorm rooms, complete lavatory and shower facilities, and a large study area with fireplace. Classrooms, offices, an auditorium, dining hall, library, computer lab and laundry facilities also are located on campus.

The campus is home to both Pot Creek Pueblo and historic Fort Burgwin. Pot Creek Pueblo, one of the largest prehistoric sites in the northern Rio Grande Valley, is located on the property. This site is one of the ancestral homes of modern-day Taos and Picuris pueblos, and was occupied from A.D. 1250 to 1350.

Historic Fort Burgwin was originally established in 1852. The fort served many purposes, chief among them to protect area settlers, prior to its abandonment in 1860, just before the Civil War. Reconstructed, the fort now serves as office and classroom space for campus academic programs.

In 2009, three summer terms will be offered in Taos: May term, June term and August term. May and August are short, intense terms in which students may take up to four credit hours. June term is a longer, more traditional summer term that allows students to take up to nine hours of coursework. Course offerings vary year-

to-year and are designed to be relevant to the Southwest. Courses are heavily field trip-oriented to best take advantage of the campus's proximity to important Northern New Mexico cultural sites. Plans for a full 15-credit fall term are planned for 2009, pending the completion of additional student housing and campus facilities.

Literature describing the campus and its programs is available from the SMU-in-Taos Office, Southern Methodist University, PO Box 750145, Dallas TX 75275, 214-768-3657. Course descriptions and additional information can be found at smu.edu/taos, or e-mail at smutaos@smu.edu.

OAK RIDGE ASSOCIATED UNIVERSITIES (ORAU)

Since 1953, students and faculty of Southern Methodist University have benefited from its membership in Oak Ridge Associated Universities. ORAU is a consortium of colleges and universities and a management and operating contractor for the U.S. Department of Energy located in Oak Ridge, Tennessee. ORAU works with its member institutions to help their students and faculty gain access to federal research facilities throughout the country; to keep its members informed about opportunities for fellowship, scholarship and research appointments; and to organize research alliances among its members.

Through the Oak Ridge Institute for Science and Education (the DOE facility that ORAU operates), undergraduates, graduates, postgraduates and faculty enjoy access to a multitude of opportunities for study and research. Students can participate in programs covering a wide variety of disciplines, including business, Earth sciences, epidemiology, engineering, physics, geological sciences, pharmacology, ocean sciences, biomedical sciences, nuclear chemistry and mathematics.

ORAU's Office of Partnership Development seeks opportunities for partnerships and alliances among ORAU's members, private industry and major federal facilities. Activities include faculty development programs, such as the Ralph E. Powe Junior Faculty Enhancement Awards, the Visiting Industrial Scientist Program and various services to chief research officers.

For more information about ORAU and its programs, contact Dr. James E. Quick, ORAU Councilor for Southern Methodist University, at 214-768-4345, or Monnie E. Champion, ORAU Corporate Secretary, at 423-576-3306; or visit the ORAU home page at orau.org.

Right to Know

Southern Methodist University is pleased to provide information regarding academic programs, enrollment, financial aid, public safety, athletics and services for persons with disabilities. The information is available in a conveniently accessible website at smu.edu/srk. Students also may obtain paper copies of this information by contacting the appropriate office listed below. Disclosure of this information is pursuant to requirements of the Higher Education Act and the Campus Security Act.

1. **Academic Programs**
   Provost Office, Perkins Administration Building, Room 219
   214-768-3219
   a. Current degree programs and other educational and training programs.
   b. Instructional, laboratory and other physical facilities relating to the academic program.
   c. Faculty and other instructional personnel.
   d. Names of associations, agencies or governmental bodies that accredit, approve or license the institution and its programs and the procedures by which documents describing that activity may be reviewed.

2. **Enrollment**
   Registrar, Blanton Student Services Building, Room 101
   214-768-3417
   a. *Graduation Rates* – The completion or graduation rate of the institution's certificate- or degree-seeking, full-time undergraduate students and students who receive athletically related financial aid.
   b. *Privacy of Student Education Records* – The Family Educational Rights and Privacy Act governs Southern Methodist University's maintenance and disclosure of a student's education records. FERPA provides students the right to inspect and review their education records and to seek amendment of those records that they believe to be inaccurate, misleading or otherwise in violation of their privacy rights. Further, FERPA prevents SMU from disclosing personally identifiable information about a student to outside third parties, except under specific circumstances outlined in SMU's Policy Manual.
   c. *Withdrawal* – Requirements and procedures for officially withdrawing from the institution.

3. **Financial Aid**
   Director of Financial Aid, Blanton Student Services Building, Room 212
   214-768-3417
   a. Financial assistance available to students enrolled in the institution.
   b. Cost of attending the institution, including tuition and fees charged to full-time and part-time students, estimates of costs for necessary books and supplies, estimates of typical charges for room and board, estimates of transportation costs for students, and any additional cost of a program in which a student is enrolled or expresses a specific interest.
   c. Terms and conditions under which students receiving Federal Family Education Loan or Federal Perkins Loan assistance may obtain deferral of the repayment of the principal and interest of the loan for:
      i. Service under the Peace Corps Act;
      ii. Service under the Domestic Volunteer Service Act of 1973; or
      iii. Comparable service as a volunteer for a tax-exempt organization of demonstrated effectiveness in the field of community service.

d. The requirements for return of Title IV grant or loan assistance.
e. Enrollment status of students participating in SMU Study Abroad programs, for the purpose of applying for federal financial aid.

4. Student Financials

Director of Student Financials
Blanton Student Services Building, Room 212
214-768-3417

a. Tuition and fees.
b. Living on campus.
c. Optional and course fees.
d. Financial policies.
e. Administrative fees and deposits.
f. Payment options.
g. Any refund policy with which the institution is required to comply for the return of unearned tuition and fees or other refundable portions of costs paid to the institution.

5. Services for Students With Disabilities

220 Memorial Health Center
214-768-4557

A description of special facilities and services available to students with disabilities.

6. Athletics

Associate Athletic Director for Student-Athlete Services
316 Loyd Center
214-768-1650

a. Athletic program participation rates and financial aid support.
b. Graduation or completion rates of student athletes.
c. Athletic program operating expenses and revenues.
d. Coaching staffs.

7. Campus Police

SMU Police Department
Patterson Hall
214-768-1582

Southern Methodist University's Annual Security Report includes statistics for the previous three years concerning reported crimes that occurred on campus, in certain off-campus buildings or property owned or controlled by SMU, and on public property within or immediately adjacent to/accessible from the campus. The report also includes institutional policies concerning campus security, such as policies concerning alcohol and drug use, crime prevention, the reporting of crimes, sexual assault, and other related matters.

The information listed above is available on a conveniently accessible website at smu.edu/srk.

BOBBY B. LYLE SCHOOL OF ENGINEERING

The Lyle School of Engineering traces its roots to 1925, when the Technical Club of Dallas, a professional organization of practicing engineers, petitioned SMU to fulfill the need for an engineering school in the Southwest. The Lyle School of Engineering has grown to become a thriving school, with graduate programs in a variety of areas.

Corporate support for the engineering school has generated a remarkable array of equipment and laboratories. Recent additions include a microwave lab from General Dynamics and a robotics lab from General Electric. Additional laboratories are being developed with funds from AT&T and Southwestern Bell. The Dallas area's national prominence in high technology and research is a major benefit for the Lyle School of Engineering.

All programs of education and research in engineering and applied science are conducted through the Lyle School of Engineering. The school is organized into the following five departments: Computer Science and Engineering; Electrical Engineering; Mechanical Engineering; Engineering Management, Information and Systems; and Environmental and Civil Engineering.

Degree Programs

The Lyle School of Engineering offers curricula leading to M.S., Doctor of Engineering and Ph.D. degrees. The M.S. and Ph.D. degrees generally are directed toward specific branches of engineering and applied science, whereas the curricula for the professional degree of Doctor of Engineering is directed toward professional practice based on a broad range of engineering fundamentals. All graduate programs are individually designed in conference between the student and his or her supervisory committee.

The following table shows the major areas in which students may major at the several graduate-degree levels:

Transcript		*Degree or Diploma*	
Dept.	*Major Area*	*Master*	*Doctor*
CSE	Computer Engineering	M.S.Cp.E.	Ph.D.
CSE	Computer Science	M.S.	Ph.D.
CSE	Security Engineering	M.S.	
CSE	Software Engineering	M.S.	D.Engr.
EE	Electrical Engineering	M.S.E.E.	Ph.D.
EE	Telecommunications	M.S.	
EMIS	Engineering Management	M.S.E.M.	D.Engr.
EMIS	Information Engineering and Management	M.S.I.E.M.	
EMIS	Operations Research	M.S.	Ph.D.
EMIS	Systems Engineering	M.S.	Ph.D.
ENCE	Civil Engineering	M.S.C.E.	
ENCE	Environmental Engineering	M.S.Env.E.	
ENCE	Environmental Science Majors in: Environmental Science; Environmental Systems Management; and Hazardous and Waste Materials Management	M.S.E.S.	
ENCE	Facilities Management	M.S.F.M.	
ME	Mechanical Engineering	M.S.M.E.	Ph.D.
ME	Manufacturing Systems Management	M.S.	
ME	Packaging of Electronic and Optical Devices	M.S.	
SS	Applied Science	M.S.	Ph.D.

Engineering education beyond the baccalaureate degree may have one or any combination of the following four objectives, some of which may relate only indirectly to a graduate degree:

1. *Upgrading:* taking advanced work to raise the level of one's formal capabilities.
2. *Updating:* keeping one's education current; for example, a person who received a B.S. degree 10 years ago may take coursework to make his or her formal education comparable to that of a person receiving a B.S. degree this year.
3. *Diversification:* seeking to obtain formal education in another field, but not necessarily at a higher degree level.
4. *Maturing:* adding new perspectives on one's own field without raising the academic level of the education.

Admission

Applicants who hold baccalaureate or higher degrees in engineering, mathematics or the sciences from a U.S. college or university accredited by a regional accrediting association, or who have completed an international degree that is equivalent to a U.S. Bachelor's degree from a college or university of recognized standing, will be considered for admission to the Graduate Division of the Lyle School of Engineering for the purpose of pursuing work leading to an advanced degree in engineering or applied science. Each case is considered on an individual basis, and due to the wide variations in student education, past performance, age, experience and academic objective, individualized graduate-program requirements for each student may be anticipated.

Admission Requirements

Applicants for admission to the Graduate Division must have a minimum GPA of 3.0 on a 4.0 scale for all previous undergraduate and graduate studies. Three letters of recommendation are required for all doctoral applicants and for all applicants requesting financial aid. In addition, an official GRE general test for graduate admissions is required in the following cases: 1) for Master's applicants in civil engineering, computer engineering, computer science, electrical engineering, environmental engineering, environmental and mechanical engineering programs; 2) for all doctoral applicants; and 3) for all applicants requesting financial aid.

Graduate students applying for admission to the Lyle School of Engineering are required to pay an appropriate application fee, which must accompany the application. Applications will not be considered unless the complete official transcripts of the applicant's prior undergraduate and graduate work are in the possession of the Graduate Division. The transcript is regarded as official only if it is received directly from the registrar of the institution in which the work was done, or if it is an original and authenticated transcript bearing the institutional seal. A Statement of Purpose is required.

Graduates from foreign countries are required to submit three letters of recommendation and a notarized financial certification form. All international students whose native language is not English and who have not graduated from an American university must submit a TOEFL English proficiency test or its equivalent with a minimum score of 550 on the paper-based examination, 213 on the computer-based examination or 79 on the Internet-based examination. For further information, write to TOEFL, PO Box 899, Princeton NJ 08541, U.S.A., or visit their website: www.TOEFL.org.

Students may apply for admission at any time. However, initial review for admission in a given term is dependent upon receipt by the Graduate Division of all requisite application materials by no later than July 1 for fall admission, November 15 for spring admission and April 15 for summer admission. *All international students* use the following dates: May 15 for fall admission, September 1 for spring admission and February 1 for summer admission. Students should write directly to Graduate Admissions, Lyle School of Engineering, Southern Methodist University, Dallas TX 75275-0335. The student will be supplied with the necessary application forms, which then must be returned to the same office.

Readmission of Students

Students who formerly attended SMU but who did not attend the immediately prior regular term or terms (not including the summer session) are considered readmission students and are required to file an application for readmission by the application deadline. If a student applies for readmission, all incomplete grades must be removed prior to readmission.

Financial Aid

Graduate students who would like to be considered for financial aid must first be accepted for admission to the Lyle School of Engineering. For financial aid from the Lyle School of Engineering, apply to the Office of the Associate Dean. For other sources of financial aid, apply to the Office of Financial Aid, SMU, PO Box 750196, Dallas TX 75275-0196. All applicants will be considered for Texas Tuition Equalization Grant eligibility.

Residence Hall Directorships

A limited number of residence hall directorships are offered to men and women graduate students. These positions offer room and board in a residence hall plus a monthly stipend. Students who have been admitted to the graduate school may request applications from the Office of Residence Life, Southern Methodist University, PO Box 750452, Dallas TX 75275-0452.

Scholarships

Scholarships are available for students whose scholastic attainments are outstanding. Holders of scholarships must maintain a grade average of *B*.

Graduate Assistantships

Graduate assistantships for teaching and research are available in the Lyle School of Engineering. These carry monthly pay and tuition benefits. The school also has a limited number of instructorships. Applications for these appointments should be submitted before March 1 to the individual department of interest.

ADMISSION TO THE MASTER'S PROGRAM

Admission to the Graduate Division of the Lyle School of Engineering is a prerequisite to post-baccalaureate registration for any graduate course or to any program of graduate study. A student wishing to study for a Master's degree may be admitted on either a regular or a conditional basis.

Regular Admission

After submission of a complete application, an applicant is evaluated for regular admission. Typically, the following requirements must be satisfied for regular admission:

- Completion of a Bachelor's degree from a U.S. college or university accredited by a regional accrediting association or completion of an international degree that is equivalent to a U.S. Bachelor's degree from a college or university of recognized standing. Each program has additional information on appropriate academic backgrounds required for admission into that program.
- A minimum GPA of 3.0 on a 4.0 scale for all previous undergraduate and graduate studies
- Submission of a complete application, including a statement of purpose, official transcripts for all previous undergraduate and graduate studies and payment of the appropriate application fee.

A score of 650 or higher on the quantitative portion of the GRE graduate school entry general test for the following programs:

- Civil Engineering.
- Computer Engineering.
- Computer Science.
- Electrical Engineering.
- Environmental Engineering.
- Environmental Science.
- Mechanical Engineering.

Graduates from foreign countries are required to submit three letters of recommendation and a notarized financial certification form. All international students whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English language proficiency score before being considered for admission, as follows:

- 550 – paper-based examination.
- 213 – computer-based examination.
- 79 – Internet-based examination.

Conditional Admission

An applicant may be offered admission to the Graduate Division on a conditional basis to ascertain his or her ability to successfully pursue graduate work. The necessity for such a conditional admission may arise when a student's undergraduate program, however high in quality, does not provide a completely adequate base on which to build the particular graduate program desired by the student. This may be due to a variety of reasons, of which the following are a few examples:

a. The undergraduate program may have been taken so many years ago that it differs from what is offered today.
b. The undergraduate degree may have been completed in a field other than that in which the Master's degree is sought.
c. Despite strong evidence that the student possesses both the necessary qualities

and the motivation to succeed in graduate study, his or her undergraduate record may have been undistinguished.

d. The student has not been awarded a Bachelor's degree because he or she is currently enrolled in the final academic term.

A student who is admitted on a conditional basis may be required to take up to 12 term credit hours of coursework beyond the minimum 30 term credit hours required for the Master's degree. Although a necessary part of the student's plan of study, such extra courses are admission requirements and cannot be counted in determining progress toward satisfaction of the minimum requirements for the Master's degree. Because they provide a connecting path between the student's previous work and the graduate coursework, these extra courses are termed *articulation courses*. When the articulation coursework has been completed with an average grade of *B* (3.0 GPA) or better, the student's admission classification is changed from conditional to regular.

DEGREE REQUIREMENTS

The minimum credit hour requirement for the Master's degree in the Lyle School of Engineering is 30 term credit hours beyond the baccalaureate, of which six term credit hours may be in a thesis. Additional hours may be required depending on the student's background, objectives of the degree program and the demands of the discipline.

Any student whose articulation into engineering or whose objective will require more than 12 term credit hours of articulation courses will be denied admission to the Graduate Division. Such students should enroll in additional undergraduate courses until these deficiencies are removed. The major department should be consulted for counseling information.

All Lyle School of Engineering coursework satisfying degree requirements must be in graduate courses numbered 7000 and above.

All work for the Master's degree must be completed no later than seven years after matriculation.

Students must complete any required articulation courses with a minimum GPA of 3.0.

Admission to candidacy is automatically achieved when the student has obtained 12 term credit hours with a minimum 3.0 GPA and that student has filed a degree plan. A student who fails to achieve this standard of performance may be required to take additional courses to satisfy the requirements of his or her degree plan and to bring his or her GPA to 3.0 or better or may be asked to discontinue graduate study.

All work attempted for the Master's degree must be completed with an overall GPA of 3.0 or better. A grade of *D* obtained by a student will be figured into his or her overall GPA, but cannot be applied to his or her degree plan.

Study Loads

The Graduate Division faculty expects its students to fully meet the rigorous demands of its program. For many students, this will mean a weekly time investment averaging at least four hours for each term credit hour of graduate registration. This figure derives from experience that shows that each hour of class work generates three hours of homework. Each student should bear this in mind in working out a schedule of studies.

Students desiring special counseling concerning an appropriate study load should consult their faculty adviser or the director of the Graduate Division.

All international students are required to be full-time students, taking nine to 12 term credit hours for each fall and spring term.

Part-time students are allowed to register for a maximum of six term credit hours. Students are considered part-time if they hold a full-time job. Students who have a grade of incomplete can register for a maximum of three term credit hours until the incomplete grade is removed.

Articulation Course Requirements

A recent engineering graduate with an undergraduate GPA of approximately 3.0 or better and pursuing a Master's program in the Bachelor's degree field will have few, if any, problems articulating into the Master's program.

Engineering graduate students have a wide range of preparatory education, industrial experience, age and academic objectives. It is often difficult to articulate these highly variable factors when determining educational programs in engineering. As a result, a plan of study often includes a series of specific courses that articulate an individual student's previous education and experience into an established educational program.

Students are required to complete these articulation courses, maintaining a minimum 3.0 GPA. The student who fails to achieve this record is automatically dropped from the graduate program, may not enroll in graduate courses and is denied the right to petition for readmission.

Students who maintain the requisite minimum 3.0 GPA in these courses may advance into the balance of their plan of study. As nearly as possible, these articulation courses should be completed before the courses in the balance of the plan of study are attempted.

Major Department Requirement

The program in the major field usually amounts to at least 18 term credit hours and may vary with the discipline. These include basic curriculum core courses, plus electives in the particular area of interest to the student. In some disciplines, a thesis may be required. The courses are drawn from the various offerings of the department of the Lyle School of Engineering, as well as other departments of SMU outside the school. Specific requirements in the individual areas of concentration may be obtained from the appropriate department or the Graduate Division.

The Minor Requirement

Minor work must be in an area other than the major. This is usually associated with six to 12 term credit hours of courses. In special cases, this requirement may be modified, but only with the approval of the faculty adviser, the curriculum chair and the associate dean.

Thesis Requirement

When a thesis is not required by a department, the student seeking a Master's degree has the option of writing a thesis or of taking an equivalent number of term credit hours of additional coursework.

The decision to choose the thesis option should be made by the student in consultation with the adviser. In some cases, a student may require a thesis adviser other than the faculty adviser. The associate dean, with the advice of the major department chair, appoints the thesis adviser.

All Master's degree candidates who present a thesis in partial fulfillment of their degree requirements must pass a written and/or oral examination, administered by an examining committee recommended by the major department chair and appointed by the associate dean. The oral examination involves, largely, a defense of the thesis, although questions may be asked in areas that relate to the student's

program of study. At least three faculty members must participate in all examinations, and one must be chosen from outside the major area to examine the student's general knowledge of the areas represented by the minor.

The thesis format must follow the University guidelines as indicated in the *Guidelines for Preparation of Theses and Dissertations.* After successful completion of the thesis defense, the thesis director must sign the abstract original, and all the faculty members attending the final examination must sign the half-title page of the thesis. After the thesis has been checked and approved by the Lyle School of Engineering examiner, the thesis is uploaded to the SMU/UMI thesis submission website. One extra copy of the abstract signed by the adviser and one copy of the original half-title page with signatures must be delivered to the office of the director of Graduate Student Experience before the final examination period in a regular term and before examinations in a summer term.

An announcement of all scheduled examinations must be sent to the associate dean. Using the form provided for the purpose, the examining committee shall report in writing to the associate dean not later than one week before the time for conferring the degree whether all work has been completed in a satisfactory manner and whether, on the basis of the final examination, the student is recommended for the desired degree. In no case may this examination be scheduled earlier than six months before the degree is to be conferred.

FACULTY ADVISER

The faculty adviser is appointed by the chair, subject to approval by the associate dean. It is the adviser's responsibility to review and eventually approve the student's specific plan of study, to check on subsequent progress and to supervise the preparation of the thesis if one is required. It is the responsibility of the faculty adviser to secure approval of the plan of study by the Graduate Division and to arrange for the appointment of the final examination committee.

Once the plan of study is approved, it becomes the curriculum for the student, and deviations are permitted only if the student obtains formal approval for the change from the faculty adviser, department chair and associate dean. All such approved changes are incorporated into the student's plan of study and are placed on file in the office of the associate dean.

PROBATION AND SUSPENSION

A student with a GPA lower than 3.0 will be placed on probation, and his or her record will be reviewed at the closing of each term. A student on probation for two terms can be placed on suspension only to be readmitted by special approval from the faculty adviser, department chair and associate dean. A student who does not meet his or her suspension conditions in the allotted time stated at the time of acceptance will be permanently suspended.

TRANSFER OF CREDITS

Generally, up to six term credit hours of graduate courses may be transferred from an institution approved by the Graduate Division, provided that such courses 1) were completed in the five years prior to matriculation, 2) carried graduate credit, 3) were not used to meet the requirements of an undergraduate degree and 4) earned grades of *B-* or higher.

Grades of courses transferred for credit are neither recorded nor used in computing GPAs. Acceptance of transfer credit requires approval of the student's faculty adviser, department chair and the associate dean.

The request to transfer credit must be made, using the appropriate forms, during the term of matriculation to the Graduate Division. Usually, this is done at the time the detailed plan of study is developed in consultation with the faculty adviser. The plan of study must be filed with the Graduate Division during the term of matriculation. Transfer of credit for courses that are taken at other institutions after matriculation into the Graduate Division in the Lyle School of Engineering is not normally permitted. Any deviations must be approved in writing by the adviser, department chair and the associate dean prior to such action and will be granted only under extenuating circumstances, as determined by each department.

FAST SECOND MASTER'S DEGREE

Students who are currently enrolled in an SMU Lyle graduate program and who are seeking a new Master's degree from SMU Lyle must take a minimum of 18 term credit hours of Lyle graduate coursework for the new SMU Lyle Master's degree, and these hours will not be applied toward another SMU graduate degree. In such cases, the Master's degree will not be awarded until a minimum of 30 term credit hours of graduate coursework has been completed at SMU.

Students who hold an SMU graduate degree and who are seeking a new Master's degree from SMU Lyle must take a minimum of 18 term credit hours of graduate coursework for the new Master's degree, and these hours must not have been applied toward another SMU graduate degree.

MASTER'S DEGREE FROM SPECIAL STUDIES

Master's degree programs in the Lyle School of Engineering also may be pursued in areas that do not belong strictly to any department, but nevertheless are meaningful in terms of courses offered by the school and faculty expertise. These programs are individually planned and follow relevant guidelines set forth in the previous paragraphs. In such cases, any faculty member of the Lyle School of Engineering may be assigned as the faculty adviser by the associate dean.

THE 4+1 MASTER'S DEGREE PROGRAM

The 4+1 program permits the SMU-Lyle engineering student to study toward B.S. and M.S. degrees simultaneously and with possibly fewer courses than if taken separately. Up to nine term credit hours of graduate coursework can be applied toward fulfilling the undergraduate degree requirements. In such cases, students may fulfill both Bachelor's and Master's degree requirements in as few as 21 term credit hours beyond the Bachelor's coursework.

Because the graduate work is spread over two academic years, students have a greater selection of courses in both their undergraduate and graduate studies and are able to complete an M.S. thesis, if desired. The student must work closely with his or her academic adviser to ensure that the requirements of the 4+1 program, the B.S. degree and the M.S. degree are all met.

Requirements

For students admitted to the 4+1 program, up to nine term credit hours of graduate courses (7000 level and above) may be applied toward fulfilling the student's undergraduate program requirements. The student must complete a minimum of 21 term credit hours of graduate coursework at SMU beyond the undergraduate residency requirement to satisfy the graduate residency requirement. Any coursework that overlaps for credit for both B.S. and M.S. degrees must be declared for dual credit before the last day to add/drop of the term in which the course is taken and must be taken at the graduate level.

Admission Requirements

For admission to the 4+1 program, the student must:

1. Be enrolled in an undergraduate program in the Lyle School of Engineering.
2. Have achieved junior-level status.
3. Apply no later than one year prior to the time he or she would graduate with a B.S. degree.
4. Have an overall GPA of 3.0 or higher.
5. Have three letters of recommendation, one from the student's academic adviser and two from other faculty members in the Lyle School of Engineering.
6. Be accepted into the desired M.S. program.

Bachelor's Degree Requirements

All undergraduate degree requirements must be satisfied, with up to nine term credit hours of graduate coursework applying toward the satisfaction of those requirements.

Master's Degree Requirements

To receive a Master's degree under the 4+1 program, the student must:

1. Have a cumulative GPA of 3.0 in the M.S. degree coursework (including the graduate coursework applied toward the satisfaction of those requirements).
2. Satisfy all requirements for the Bachelor's and Master's degrees. The Bachelor's degree requirements must be fulfilled prior to or at the same time as the Master's degree requirements.

GRADUATE COOPERATIVE EDUCATION PROGRAM

The graduate co-op program is intended to allow for up to three terms of relevant professional work experience to enhance the academic experience for graduate students in the Lyle School of Engineering. The work experience must be related to the student's major area of study and is subject to these regulations:

1. Students are eligible to apply for graduate co-op only *after* completion of the first term.
2. Students must be in good academic standing to be admitted to the co-op with a minimum GPA of 3.0.
3. Students must secure their own co-op position.
4. Co-op positions must be full-time, and subsequent co-op positions must be with the same employer.
5. Students may not quit co-op assignments in midterm to seek a position with a different employer.
6. All paperwork must be completed prior to the deadline:
   a. SMU graduate co-op application (requires adviser and department chair approval).
   b. Legal agreement between SMU and employer (requires supervisor and SMU provost approval).
   c. Curricular practical training request form for international students. (CPT form requires adviser and department chair approval.)
   d. Offer letter from employer stating beginning and ending dates, salary per hour and job description on company letterhead and signed by supervisor. The letter must also indicate that the position is full-time (40 hours per week).
   e. Application deadline: All co-op paperwork for the work term is due by the deadline set each term by the graduate co-op director, and the deadline is approximately two weeks before the start of the term.

Note: *The process to obtain an I-20 Certificate of Eligibility from English for Internationals takes five business days after the co-op paperwork has been completed.*

7. The duration of the co-op work term must coincide with the SMU academic term.
8. Students must be enrolled in graduate co-op course SS 7099 while on co-op work assignments.
9. Students may take no more than three course hours (one course) during a co-op work term, and only if the course is needed to graduate on time. The course may be taken on campus or by distance learning.
10. Students must complete a minimum of two, but no more than three, co-op work terms.
11. Students may complete only spring/summer or summer/fall back-to-back work terms. (Fall/spring and spring/fall back-to-back work terms are **not** allowed.)
12. Students must submit a report at the end of each work term, signed by the student's supervisor, academic adviser and department chair, no later than two weeks after the end of the co-op work term.
13. Students must read and become familiar with the graduate engineering co-op policy.

NONDEGREE STUDY – LYLE SCHOOL OF ENGINEERING

Nondegree studies are subject to the following:

1. A baccalaureate degree is required for admission.
2. Admission to nondegree study requires the consent of the program director who oversees the course(s) taken by the student.
3. Students who apply to the Lyle School of Engineering graduate programs after the deadline for admission may be offered the nondegree option to begin their studies.
4. Students applying for nondegree study must submit an application, an application fee of $75 and an official transcript from the institution that conferred the student's baccalaureate degree.
5. Students may not take more than three courses on a nondegree status.
6. Students on a nondegree study plan may apply to study toward a graduate degree. All requirements for admission must be met. After a student is admitted, he or she may petition to transfer the nondegree courses subject to approval of the adviser, department chair and associate dean.

Tuition for nondegree students is the same as tuition for students who take the course toward a degree.

Off-campus Distance Education

SMU, through its Lyle School of Engineering, has supported distance education graduate programs for more than 35 years. Courses may be taken through the Lyle School of Engineering DE program. Students can view and complete graduate-level courses at work or at home. A proctor oversees all exams that the student takes.

THE DE PROGRAM

Lyle engineering graduate course lectures are recorded "live" in one of the school's state-of-the-art tele-studio classrooms. The live classroom recording includes the lecture and all dialogue among students in the class and between the students and the professor.

The recorded lectures are then saved to a server at the Lyle School of Engineering within 24 hours of the on-campus course. Students should download the lecture to their computer and watch it within 48 hours to keep current with course content and requirements. Course handouts, syllabi and assignments are distributed via course management software. Graded homework is returned by e-mail, fax or regular mail. DE students may contact the instructor to ask questions and clarify points from the lecture by telephone, fax, electronic mail or the postal service. One great advantage to this format is that the student may replay the lecture as many times as needed. DE instruction has proven to be an effective medium for overcoming time and distance constraints, providing much-needed graduate education for qualified students.

Students are required to have a proctor for all exams. The proctor must be the student's supervisor, someone in the training or personnel department of the student's company, or a librarian or professor at a local college. A proctor may NOT be a student's relative, personal friend or subordinate at work. Proctors are required to sign an agreement with the Lyle School of Engineering detailing the responsibilities and expectations of the proctor.

Today, the Lyle School of Engineering offers DE students the opportunity to complete Master of Science degrees in professional disciplines and traditional engineering disciplines. Each of the programs is interdisciplinary in content and flexible in approach. The programs are:

GRE Not Normally Required	*GRE Required*
Engineering Management	Civil Engineering
Environmental Science	Computer Engineering
(Major in Environmental Systems Management)	Computer Science
Environmental Science	Electrical Engineering
(Major in Hazardous and Waste Materials Management)	Environmental Engineering
Facilities Management	Environmental Science
Information Engineering and Management	Mechanical Engineering
Manufacturing Systems Management	
Packaging of Optical and Electronic Devices	
Operations Research	
Security Engineering	
Software Engineering	
Systems Engineering	
Telecommunications	

More information about the Lyle School of Engineering's off-campus graduate programs can be obtained by contacting Distance Education Marketing, Lyle School of Engineering, Southern Methodist University at www.smu.edu/Lyle/Graduate/ProspectiveStudents/DistanceEducation.aspx.

Doctor of Engineering Degree

The objective of this degree is to provide students with adequate preparation to meet doctoral standards in an applied science or engineering practice. Applied science, as a focus for the doctoral degree, refers to the study of advanced theory and its application to a practical problem in order to test and verify performance and limitations. A doctorate with focus on applied science requires a high level of expertise in the theoretical aspects of the relevant scientific principles and experience with the details of the implementation of this theory on realistic problems. Engineering practice, as a focus for a Doctor of Engineering degree, is the study of the different aspects that play a role in the transfer of technology from its inception in research to the intended engineering environment. This requires a high level of expertise in (a) theoretical aspects of the relevant scientific principles, (b) solving the problems and understanding the details of the transfer and application of the technology and (c) economic issues.

A Doctor of Engineering degree is distinguished from a Doctor of Philosophy degree in that a Doctor of Philosophy is expected to make a significant advance to scientific knowledge, whereas a Doctor of Engineering is expected to have made a contribution to science by studying its implementation and participating in the transformation of knowledge into technology. Currently, the Doctor of Engineering Degree is offered with majors in engineering management and software engineering.

SEQUENCE OF EVENTS

The following events must occur in the process of obtaining a Doctor of Engineering degree. Some events may occur concurrently.

1. Acceptance into the program and assignment of an academic adviser.
2. Preparation of a formal degree plan (form labeled "Degree Plan – Doctor of Engineering") and creation of the advisory committee (Form 6-66: "Recommendation and Certification of Supervisory Committee").
3. Basic coursework.
4. Written qualifying examination.
5. Submission of written proposal for praxis project.
6. Oral qualifying examination and proposal presentation.
7. Admission to candidacy (form labeled "Admission to Candidacy").
8. Preparation of praxis.
9. Review of praxis by project supervisor and chair of committee.
10. Presentation and defense of praxis to the committee (form labeled "Report on Thesis or Dissertation and/or Final Examination").

ADMISSIONS CRITERIA

Persons with a B.S. or equivalent baccalaureate degree and a Master's degree may qualify for admission. The undergraduate degree must be in a technical or applied science area. This includes all engineering degrees as well as degrees in mathematics and applied sciences. The Master's degree may be in a technical area or other areas such as business administration or economics.

INITIAL ADVISING

Upon acceptance into the Doctor of Engineering program, the student is assigned an academic adviser. This adviser is a member of the full-time faculty in the student's home department. The selection of the adviser is an administrative decision that may not be connected to the student's academic interests. At the outset, the student should identify whether the focus of the doctorate will be in applied science or in engineering practice. The adviser and the student will prepare a formal degree

plan based on the student's academic background and declared interests and objectives. This plan of study should present clearly how past and proposed coursework will satisfy the requirements for the degree. It should also provide a term-by-term schedule for taking courses consistent with current course offering projections. It is at this point that the student and the adviser organize an *advisory committee.* This committee must be composed of five faculty members, at least two of whom will be full-time faculty in the Engineering Management, Information and Systems Department. Other members of the advisory committee may come from related areas such as engineering, business or economics. One committee member must be from outside the Lyle School of Engineering. The advisory committee must be approved by the chair of the department and the associate dean. The advisory committee may be modified as the student progresses in the program. The initial task of this committee is to review and officially approve the degree plan.

ACADEMIC CREDIT REQUIREMENT

Requirements for Doctor of Engineering With a Major in Engineering Management

The total term credit hour requirement is 78–66 hours of graduate coursework and 12 hours devoted to the praxis project. Post-baccalaureate coursework from other institutions and other graduate degrees may be applied toward the degree requisites subject to approval of the advisory committee. There must be a minimum of 36 term hours of graduate coursework and a minimum of 12 term hours of praxis project work, none of which have been nor can be applied to any other degree. A degree plan must satisfy the following requirements:

Engineering Management: 24 Term Hours. These hours must come from graduate-level courses in quantitative and qualitative aspects of managing in a modern technical environment. Courses in the areas of engineering management, management science, operations research, operations management, production management and other related fields may qualify. All graduate courses in engineering management in the EMIS Department are acceptable for this category.

Technical Specialty: 18 Term Hours. These hours must come from engineering or other technical area consistent with anticipated doctoral work demands.

Business/Economics: 9 Term Hours. These hours must come from courses in a graduate business or economics program. They should expand the student's understanding of the economic issues and problems relating to the transfer and management of technology.

Electives: 15 Term Hours. All elective hours must come from graduate-level courses and must be approved by the advisory committee. These courses should, in some way, complement and strengthen the student's program of study.

Praxis: 12 Term Hours. These are normally "in residence" hours. The student enrolls for these hours in the course of preparing the praxis project.

See the requirements for the Doctor of Engineering with a major in software engineering in the Computer Science and Engineering section of the Lyle Graduate Catalog.

Constraints

At least 18 of the 66 credit hours of coursework must be taken at SMU. The 12 credit hours devoted to the praxis must be taken in residence at SMU.

Articulation requirement for the Doctor of Engineering with a major in engineering management: 15 of the 66 credit hours of coursework must include (or be

equivalent to) EMIS 7362 Production and Operations Management, EMIS 7370 Probability and Statistics for Scientists and Engineers, EMIS 8360 Operations Research Models, EMIS 8361 Economic Decision Analysis, and EMIS 8364 Management for Engineers.

Recognition of Previous Post-Baccalaureate Coursework

Graduate-level courses may be used to fulfill the course requirements for the degree. Any course assigned to a specific requirement must be approved by the advisory committee.

THE QUALIFYING EXAMINATION

The qualifying examination marks the transition from preparation to execution of the doctoral research. Upon its successful completion, and the presentation of a research plan, the student is certified to proceed with the research directly related to the praxis. Beyond this point, the student is formally recognized as a doctoral candidate. Transition into candidacy occurs after the following three requirements are satisfied.

The Written Qualifying Examination

The written portion of the qualifying examination is composed of a battery of five tests. A member of the advisory committee administers each test. The examiner has full discretion as to the choice of material and the format and style of the written test. Usually, tests are designed to measure knowledge in an area of expertise of the instructor or on a topic from a course taught by him or her. Tests are commonly "take home" exams over the course of a week or more. It is the responsibility of the student to inquire as to the nature and format of the exam and the availability of the instructor when scheduling the exam. When the student is ready to proceed with the written portion of the qualifying examination, and when all participating examiners have been consulted and agree on a schedule, the academic adviser issues a memorandum to all members of the advisory committee formalizing the schedule for this portion of the exam.

The Written Research Proposal

A formal document, describing in detail the proposed research project that constitutes the praxis, must be submitted to the advisory committee in time to be read prior to the oral presentation. This document outlines the responsibilities of the praxis committee as well as presents a realistic plan and time schedule for the completion of the praxis.

The Oral Qualifying Examination and Proposal Presentation

The oral qualifying examination and the oral presentation of the research project proposal may be presented following the successful completion of the written examination and when the members of the advisory committee have had time to review the written research proposal. The oral qualifying examination is a continuation of the written qualifying examination. At this time, the five examiners may proceed with an oral examination of the student. After this, the student presents the proposed praxis project. The student must be prepared to defend the proposal to the advisory committee and additional members who will integrate the praxis committee.

THE DOCTORATE PRAXIS PROJECT

Composition of the Praxis Committee

The purpose of the praxis committee is to supervise the student's praxis project. The praxis committee may add up to two members to the advisory committee to include faculty members from other areas of specialization or cognizant members

from industry which may contribute to the praxis. The chair of the committee is required to be a member of the full-time EMIS faculty; however, a different committee member may act as the praxis director.

The Project and Final Defense

As a culmination of the doctoral program, the student must perform a suitable engineering praxis (practical engineering study), including both a written report and an oral presentation of the results. The scope of the praxis may be broad or narrow and may involve engineering design, development or any other major category of engineering work, typically revolving around a well-defined project relevant to current engineering practice. Good scholarship, including recognition of both previous and current work in the subject area, is required. The praxis may be conducted on campus or at an industrial location. The proposal will (a) outline the general technical scope of the project, (b) state the economic and technical relevance of the work and (c) give a time schedule for accomplishing the project. It is expected that this proposal will be worked out in close consultation with the faculty member supervising the work and cognizant industry people when the project is to be conducted off campus. Once the project is set into motion, the student is expected to adhere to the time schedule and to keep the advisory committee informed on a regular basis of progress made. The project may focus on a well-defined practical problem or on a more general theoretical development. If the focus is a practical problem, economic considerations must also be incorporated in the praxis. If the focus is more general, the advisory committee will determine whether or not economic aspects will be required.

The Praxis Report

The praxis report is expected to be a mature and competent piece of writing. The praxis format must follow the University guidelines as indicated in the *Guidelines for Preparation of Theses and Dissertations.* Upon successful completion of the praxis defense, the abstract original must be signed by the praxis director, and the original half-title page of the praxis must be signed by all the faculty members attending the final examination. After the praxis has been checked and approved by the Lyle School of Engineering examiner, the praxis is uploaded electronically to the SMU/UMI submission website. One extra copy of the abstract signed by the adviser and one copy of the original half-title page with signatures must be delivered to the director of Graduate Student Experience before the final examination period in a regular term and before examinations in a summer term.

Doctor of Philosophy Degree

General requirements for the Ph.D. degree include the following components: 1) total academic credit, 2) residence requirements, 3) course requirements, 4) preliminary counseling examination, 5) qualifying examination, 6) admission to candidacy, 7) dissertation, 8) final examination and 9) supervisory committee. A student admitted to a doctoral program is expected to have been awarded a Master's degree in the same or a closely related program or to earn such a Master's degree during the course of the program.

The following sections define and discuss these general requirements.

TOTAL ACADEMIC CREDIT

The Lyle School of Engineering requires for the Ph.D. degree a minimum academic credit of 54 term credit hours earned in coursework beyond the baccalaureate degree or 24 term credit hours earned in coursework beyond a Master's degree, in addition to 24 term credit hours earned in dissertation work. There must be a minimum of 24 term credit hours of graduate coursework and a minimum of 24 term credit hours of dissertation work, none of which have been nor can be applied to any other degree. The student's supervisory committee determines the precise amount of course credit to be required, subject to the approval of the department chair and the associate dean. A student who is actively working on his or her dissertation must be enrolled in dissertation study each term until completion of all requirements for the Ph.D. degree.

RESIDENCE REQUIREMENT

The term "residence requirement" refers to the minimum number of required academic credits a student must complete while properly enrolled at SMU. The residence requirement is 30 term credit hours of graduate credit, normally the last 30.

TIME LIMITATIONS

The Ph.D. degree is given in recognition of the highest attainment in a specific field. It requires novel, high-quality research work recognized and accepted by other scholars in the field. Due to this need for timeliness, all requirements for the Ph.D. degree must be satisfied within five years after the date the qualifying examination is passed. If such period has expired without successful completion of the Ph.D. degree, the associate dean, in consultation with the thesis adviser and the department chair, may ask the student to retake the Ph.D. qualifying examination or may disallow the student from further study.

PRELIMINARY COUNSELING EXAMINATION

Upon admission of each student into the program, the associate dean, on the recommendation of the department chair, appoints a faculty adviser. The faculty adviser is responsible for providing the student with advice on a proper plan of study on fundamental courses in the discipline to prepare for the preliminary counseling examination, which is designed to establish the academic strengths and weaknesses of the student. If required by the department, the individual department determines the format of the preliminary counseling examination. The background expected for this examination is similar to that of a Master's level, and the final examination for the Master's degree may substitute for this exam for students who complete Master's degrees at SMU. Depending on the results of the preliminary counseling examination, one of the following three actions is taken: 1) the student is allowed to take advanced courses for the Ph.D., 2) the student is disallowed from further study at SMU or 3) remedial action in areas of academic weakness is recommended.

Every student who is admitted to the Ph.D. program must form a supervisory committee with the approval of the dissertation director, the department chair and the associate dean. Because the chair of this committee normally will also be the student's dissertation director, the student should decide upon a general area of the dissertation before requesting the appointment of a supervisory committee. It is essential that the student do this quickly because there are no assurances that graduate work completed before the appointment of the committee will be accepted as part of the Ph.D. program.

COURSE REQUIREMENTS

The minimum academic coursework of 54 term credit hours should include a major as well as a minor area of investigation. The individual departments identify specific course requirements for these areas. As a general guideline, at least 12 term credit hours are required for the minor, which should be in an area providing breadth as well as support to the major field of investigation.

For a Ph.D. program, qualifying examinations and the dissertation are paramount. Course requirements are identified to facilitate the student's training toward the qualifying examination. Of the 24 term credit hours required in coursework beyond a Master's degree, 12 term credit hours must be taken at SMU. Generally, up to 12 term credit hours of graduate courses may be transferred into the Ph.D. program from an institution approved by the Graduate Division, provided that such courses 1) were completed in the five years prior to matriculation, 2) were taken toward a Ph.D. degree and 3) received grades of *B-* or higher. The request to transfer credit must be made using appropriate forms during the term of matriculation to the Graduate Division. Grades of courses transferred for credit are neither recorded nor used in computing GPAs. Acceptance of transfer credit requires approval of the student's faculty adviser, department chair and the associate dean. Transfer of any credit for courses taken at other institutions after admission to SMU is not normally permitted.

QUALIFYING EXAMINATION PROCESS

These examinations must be taken after the student has completed some of the advanced coursework in the major and minor fields of investigation.

Each department within the Lyle School of Engineering specifies the formats, schedules and areas for the qualifying examinations. The student should contact his or her department for these requirements.

This examination process is comprehensive in scope, covering the student's entire academic career, and includes the major and minor areas planned for the Ph.D. degree. It is conducted by the supervisory committee with the aid of faculty members drawn from the major and minor areas of concentration and consists of both written and oral parts. As part of the oral examination, the student will be required to discuss the proposed dissertation topic. This is desirable because a student's program of study should be supportive of his or her intended dissertation research. Successful performance on the examination results in a recommendation that the student be admitted to candidacy for the Ph.D. degree. The committee may believe that, while a student passed the major parts of the examination, his or her performance disclosed weaknesses requiring further coursework. The committee may then modify the student's plan of study to include specific additional courses before he or she may be recommended for admission to candidacy.

Should the student fail the examination process, the supervisory committee may recommend a re-examination, subject to approval by the department chair and the associate dean. The right of re-examination is not automatic; rather, it is a special

privilege recommended in those cases in which the supervisory committee believes a student has the necessary potential but needs some additional preparation.

ADMISSION TO CANDIDACY

A graduate student does not become a candidate for the Ph.D. degree until the formal application for candidacy has been approved. Such admission requires the approval of the student's supervisory committee, the department chair and the associate dean. The approval is based upon 1) passing the qualifying examination, 2) the academic record of the student as attested by a 3.0 GPA or better (4.0 = *A*), 3) selection of a tentative title for the dissertation and 4) the student's overall fitness as judged by the supervisory committee. The formal application for candidacy should be submitted as soon as these four requirements have been met, as judged by the supervisory committee.

DISSERTATION REQUIREMENT

The dissertation format must follow the *Guidelines for Preparation of Theses and Dissertations.* Each student is also expected to submit articles for publication in reputable journals and conferences appropriate to the field of research.

The most clearly distinguishing characteristic of a program leading to the Ph.D. degree is the requirement that the candidate write a dissertation embodying the results of a significant and original investigation. The dissertation is expected to be a mature and competent piece of writing and must make a significant and novel contribution to the engineering or applied science discipline. The work it reports may be basic scientific research, engineering research or creative design. The progress of the student toward the Ph.D. degree is monitored closely by the thesis adviser and the supervisory committee, with an annual report to the department chair. In the event a student is judged by the supervisory committee not to be making satisfactory progress, he or she will be placed on probation for one term, at the conclusion of which his or her progress will be reevaluated. Should the progress be found unsatisfactory, the student will be suspended.

Upon successful completion of the dissertation defense, the dissertation director must sign the abstract original, and all faculty members attending the final examination must sign the original half-title page of the dissertation. After the dissertation has been checked and approved by the Lyle School of Engineering examiner, the dissertation is uploaded electronically to the SMU/UMI submission website. One extra copy of the abstract signed by the adviser and one copy of the original half-title page with signatures must be delivered to the director of Graduate Student Experience before the final examination period in a regular term and before examinations in a summer term.

Dissertation Research in Industrial Laboratories

Under special circumstances, some students may be permitted to undertake their dissertation in industrial laboratories in the Dallas-Fort Worth area or elsewhere. This situation may arise when the research requires special laboratory facilities that are not available at SMU but that are available elsewhere. Such an operation creates special problems for both the University and the company, particularly when the dissertation research is also the student's work assignment as an employee of the company. From the viewpoint of the school, the principal requirement is that the particular research on which the dissertation is to be based be undeniably the individual work of the student. The second requirement on which the school must stand is that the dissertation results be available for free dissemination via open publication, whatever those results may be.

To minimize difficulties arising out of these requirements, the Lyle School of Engineering has adopted the following regulations:

1. The chair of the student's supervisory committee must be a member of the resident tenured or tenure-track faculty of the school.
2. The student may register for dissertation-research credit only after appointment of a dissertation director by the department chair, subject to the approval of the associate dean.
3. The supervisory committee must approve the specific character of the work to be conducted, the conditions under which it is conducted and the time schedule for completion. It is expected that the supervisory committee shall have access to the student's experimental apparatus, and the chair of that committee shall join with the dissertation director in meeting at intervals with the student at the scene of the research to evaluate the process and the conditions under which the research is carried out.
4. The dissertation director has the responsibility to ensure that the student's work is identifiably the student's own and that needed equipment belonging to SMU will not be diverted from the dissertation research by the company except in cases of extreme need.

Supervisory Committee

The membership of the supervisory committee is selected by the student in consultation with the dissertation director. After the student has obtained the written consent of those selected, he or she must obtain the written endorsement of the department chair before transmitting the list to the associate dean for official certification. The supervisory committee is made up of at least five members. Three resident tenured or tenure-track faculty members are drawn from the student's department, as well as one resident tenured or tenure-track faculty member from each minor field. The chair of the supervisory committee shall be a resident tenured or tenure-track member of the school faculty and shall normally be the dissertation director and a member of the student's department. Thus, a minimum of four members must be resident tenured or tenure-track faculty of Southern Methodist University. The supervisory committee should be constituted as early as possible after the student has begun doctoral work and normally before the completion of 15 term credit hours of work beyond the Master's degree (or 45 term credit hours of work beyond the baccalaureate degree). The associate dean is an ex officio member of all supervisory committees and should be notified in writing, at least one week in advance, of all meetings of such committees. The associate dean may, at his or her own discretion, reconstitute any supervisory committee.

The duties of a supervisory committee shall be:

1. To assist the student in interpreting all regulations governing the degree sought. This duty does not absolve the student from the sole responsibility to remain informed concerning these regulations.
2. To meet immediately after its appointment for the purpose of passing on the qualifications of the student, to discuss and approve a plan of study, and to set a tentative time schedule for the qualifying examination.
3. To discuss and approve the dissertation project proposed by the student and the plans for implementing it.
4. To participate in the qualifying examination.
5. To convene whenever needed during dissertation research to review procedure, progress and expected results, and to develop suggestions for the remainder of the work. The supervisory committee may be convened by either the chair

of the supervisory committee or the associate dean of Graduate Studies. The supervisory committee may suggest discontinuation of the student if sufficient progress toward the Ph.D. degree has not been achieved.

6. To conduct the final examination.

FINAL EXAMINATION

Upon completion of all other requirements, a final examination of the candidate will be announced, registered with the Graduate Division and subsequently conducted by the supervisory committee. The candidate must make six unbound copies of the complete draft version of his or her dissertation available to the Graduate Division for distribution to the members of the supervisory committee at least three weeks prior to scheduling of the final examination. This examination, which is conducted orally, must enable the committee to satisfy itself that the dissertation is an original piece of work, either in research or creative design; that it has been carried out in keeping with the highest standards of investigation and reporting; and that it makes a contribution to knowledge that is of value to the engineering profession or scientific community. Satisfactory performance on this examination is the last requirement to be met for the Ph.D. degree.

The degree may be awarded at the end of the term in which the final examination is passed, but the prospective candidate should note that at least one academic year must elapse between the passing of the qualifying examination and the conferring of the degree.

DEGREE OF DOCTOR OF PHILOSOPHY FROM SPECIAL STUDIES

The Doctor of Philosophy degree in the Lyle School of Engineering may be pursued in areas that do not belong strictly to any one department but nevertheless are of interest to some faculty members of the school. In such cases, the composition of the supervisory committee will be made flexible in order to allow for the interdisciplinary nature of the program, with the single restriction that at least three of the five members of the supervisory committee are tenured or tenure-track faculty members in the Lyle School of Engineering.

All courses offered in the Lyle School of Engineering are identified by a two-, three- or four-letter prefix code, designating the general subject area of the course, followed by a four-digit number. The first digit specifies the approximate level of the course as follows: 7 – graduate and 8 – advanced graduate. The second digit denotes the term hours associated with the course. The last two digits specify the course numbers. Thus, CSE 7320 denotes a course offered by the Department of Computer Science and Engineering at the (7) graduate level, having three term hours and having the course number 20. The prefix codes are as follows:

CSE Department of Computer Science and Engineering
EE Department of Electrical Engineering
EMIS Department of Engineering Management, Information and Systems
ENCE Department of Environmental and Civil Engineering
ME Department of Mechanical Engineering

COMPUTER SCIENCE AND ENGINEERING

Professor Sukumaran Nair, **Chair**

Professors: Margaret H. Dunham, David W. Matula, Sukumaran Nair, Stephen A. Szygenda, Mitchell A. Thornton. **Associate Professors:** James G. Dunham, Richard V. Helgason, Jeff Tian. **Assistant Professors:** LiGuo Huang, Yuhang Wang. **Senior Lecturer:** Frank Coyle. **Lecturers:** Donald E. Evans, Mark Fontenot. **Adjunct Faculty:** Jeffrey D. Alcantara, Abdelhalim Alsharqawi, William A. Bralick, Jr., Ann E. Broihier, Hakki Candan Cankaya, Ebru Celikel, Aaron L. Estes, Dennis Frailey, Prasad N. Golla, Khalid Ishaq, Bhanu Kapoor, Mohamed Khalil, Kamran Z. Khan, Karl C. Lewis, Lun Li, Kall Loper, Matthew R. McBride, Lee D. McFearin, Freeman L. Moore, Padmaraj M.V. Nair, Robert S. Oshana, John J. Pfister, Leonid Popokh, Mohamed Omar Rayes, Stephen L. Stepoway, Raymond Van Dyke.

The department offers graduate programs in computer engineering, computer science, security engineering and software engineering. Faculty research interests include CAD methods and algorithms for digital systems design, computer arithmetic, computer architecture, configurable hardware, design automation, VLSI design, bioinformatics, database systems, data mining, design and analysis of algorithms, theory of computation, software engineering, parallel processing, mobile computing, computer networks, fault tolerance, computer security, and information assurance.

In addition to the research labs, students in the Department of Computer Science and Engineering have access to a wide range of facilities and equipment. The CSE Department's computing environment has evolved into an Ethernet-based network of personal computers and servers. General-use UNIX servers are available that run OSF1, SunOS and Linux. A wireless network is also available throughout the facilities of CSE. Access to the network is also available via open-area labs containing X terminals and PCs.

Graduate Degrees

The CSE Department currently offers seven graduate programs:

Master of Science in Computer Engineering
Master of Science (Major in Computer Science)
Master of Science (Major in Software Engineering)
Master of Science (Major in Security Engineering)
Doctor of Engineering (Major in Software Engineering)
Ph.D. (Major in Computer Engineering)
Ph.D. (Major in Computer Science)

Professional Certificates

The CSE Department currently offers seven professional certificates:

Series of Certificates in Software Engineering

Certificate in Software Engineering Fundamentals
Certificate in Software Requirements Engineering
Certificate in Software Design Engineering
Certificate in Software Construction Engineering
Certificate in Software Testing and Quality Engineering
Certificate in Software Engineering Management

Security Engineering Certificate

Certificate in Computer Security and Information Assurance

Master of Science in Computer Engineering

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for an M.S. degree, applicants are required to satisfy the following:

1. A Bachelor's degree in computer engineering, computer science or closely related discipline. Applicants with undergraduate degrees in other disciplines may also be admitted to the program and may be required to take articulation coursework.
2. A minimum GPA of 3.0 on a 4.0 scale in the student's junior and senior years.
3. A reasonable level of mathematical maturity.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for an M.S. degree, candidates are required to satisfy the following:

1. Either 24 hours of coursework and a Master's thesis or 30 hours of coursework.
2. Twelve hours of core courses. Students on campus are required to register for a seminar course (for zero hours of credit) for at least one term and secure a grade of Pass.
3. Six hours of concentration. Thesis students take six hours of thesis, instead of concentration.
4. Twelve hours of electives. All students are allowed to take at most three hours of independent study, which will be counted as one elective course.

The CSE Department requires that the courses taken constitute a coherent program leading to mastery in computer engineering. These requirements are discussed in the subsequent subsections. Any deviation from the stated requirements must be approved in writing from the student's adviser and department chair.

Articulation

All students entering the program are expected to possess knowledge equivalent to the following courses:

CSE 1341 Principles of Computer Science
CSE 1342 Programming Concepts
CSE 2341 Data Structures
CSE 2240 Assembly Language Programming and Machine Organization
CSE 2353 Discrete Computational Structures
CSE 3353 Fundamentals of Algorithms
CSE 3381 Digital Logic Design
CSE 4381 Digital Computer Design

Students with deficiencies may be granted conditional admission to the program and be required to take some of courses as articulation. Students are required to complete these articulation courses, maintaining a minimum 3.0 GPA. A student who fails to achieve this record is automatically dropped from the graduate program, may not enroll in graduate courses and may be denied the right to petition for readmission. Students who maintain the minimum 3.0 GPA in these courses may advance into the balance of their plan of study. As nearly as possible, these articulation courses should be completed before the courses in the balance of the plan of study are attempted. An articulation course must be completed before undertaking any graduate coursework, which requires it as prerequisite.

Residency and Level Requirements

A minimum of 30 graduate credits must be earned towards an M.S. degree, of which at least 24 must be earned in residency at SMU. Up to six credits may be transferred with departmental approval.

Of the 30 credit hours needed for graduation, at least nine credit hours must be at the 8000 level, with the remainder at the 7000 level or above.

Distribution of Courses

Courses are considered to be core, concentration or elective. Core courses cover material fundamental to graduate-level computer science and are required of all students. Each student is expected to specialize in some area of computer engineering. The concentration area is a mechanism by which a student can tailor a coherent program of study to his or her interests. Electives are courses taken to round out the 30-credit hour requirement. Transferred credits may be used to satisfy any of these requirements. The specific requirements are discussed in detail in the following subsections.

Course Requirements

A student who elects to take the nonthesis option must take 12 hours of core courses, six hours of concentration and 12 hours of electives. Those who elect to take thesis option will substitute the concentration with thesis hours.

Core Courses (12 hours)

CSE 7343 Operating Systems and Systems Software
CSE 7344 Computer Networks and Distributed Systems
CSE 7381 Computer Architecture
CSE 7387 Digital Systems Design
CSE 8098 Computer Science Seminar

Concentration (6 hours in one of the following programs)

Architecture (2 of the following)

CSE 7385 Microprocessor Architecture and Interfacing
CSE 8377 Fault-Tolerant Computing
CSE 8380 Parallel and Distributed Processing
CSE 8383 Advanced Computer Architecture

Design Automation (2 of the following)

CSE 7380 VLSI Algorithms
CSE 7387 Digital Systems Design
CSE 8377 Fault-Tolerant Computing
CSE 8387 Switching Theory and Applications in VLSI CAD

Networking (2 of the following)

CSE 7348 Internetworking Protocols and Programming
CSE 7349 Data and Network Security

CSE 8344 Computer Networks
CSE 8349 Advanced Network and System Security

Electives (12 hours)
CSE 7111 Intellectual Property and Information Technology
CSE 7314 Software Testing and Quality Assurance
CSE 7320 Artificial Intelligence
CSE 7330 File Organization and Database Management
CSE 7331 An Introduction to Data Mining and Related Topics
CSE 7341 Compiler Construction
CSE 7339 Computer System Security
CSE 7342 Concepts of Language Theory and Their Applications
CSE 7344 Computer Networks and Distributed Systems II
CSE 7345 Advanced Application
CSE 7320 Artificial Intelligence
CSE 7330 File Organization and Database Management
CSE 7331 An Introduction to Data Mining and Related Topics
CSE 7341 Compiler Construction
CSE 7339 Computer System Security
CSE 7342 Concepts of Language Theory and Their Applications
CSE 7344 Computer Networks and Distributed Systems II
CSE 7345 Advanced Application Programming
CSE 7348 Internetworking Protocols and Programming
CSE 7349 Data and Network Security
CSE 7350 Algorithm Engineering
CSE 7359 Software Security
CSE 7380 VLSI Algorithms
CSE 7382 Computer Graphics
CSE 7385 Microprocessor Architecture and Interfacing
CSE 7387 Digital Systems Design
CSE 8312 Software Generation and Maintenance
CSE 8313 Object-Oriented Analysis and Design
CSE 8314 Software Metrics and Quality Engineering
CSE 8316 User Interface Design
CSE 8317 Software Reliability and Safety
CSE 8320 Knowledge-Intensive Problem Solving
CSE 8321 Machine Learning and Neural Networks
CSE 8322 Natural Language Processing and Internet Applications
CSE 8325 Logic Programming
CSE 8330 Advanced Database Management Systems
CSE 8331 Data Mining
CSE 8337 Information Retrieval
CSE 8340 Advanced Topics in Software Engineering
CSE 8343 Advanced Operating Systems
CSE 8344 Computer Networks
CSE 8349 Advanced Network and System Security
CSE 8350 Algorithms II
CSE 8351 Computer Arithmetic
CSE 8353 Combinatorial Algorithms
CSE 8352 (EE 8372) Cryptography and Data Security
CSE 8355 Graph Theory: Algorithms and Applications
CSE 8358 Information Structures
CSE 8377 Fault-Tolerant Computation
CSE 8380 Parallel and Distributed Processing

CSE 8383 Advanced Computer Architecture
CSE 8386 Testing of VLSI Circuits
CSE 8387 Switching Theory and Applications in VLSI CAD
CSE 8388 Embedded Systems Design
CSE 8389 Foundations of Formal Verification and Validation
EE 7356 VLSI Design and Lab
EE 8378 Performance Modeling and Evaluation of Computer Networks
EETS 8306 Wireless, Cellular and Personal Telecommunications
EETS 8307 Telecommunications Network Management
EETS 8322 Data Compression for Multimedia Application

Thesis Option

A student may elect to write a Master's thesis, which counts as the six hours of concentration. The student must register for at least six hours under CSE (1–6)96. If the thesis option is chosen, all other requirements are the same. The six hours of thesis satisfy six of the nine required hours for advanced courses.

A Master's thesis represents one or more of the following: synthesis of divergent ideas or a scholarly critique of current literature, a creative research activity or a significant design project, the results of which must be documented in a well-written thesis. The thesis should be of publishable quality, and it is recommended that it be submitted to an appropriate conference or journal before the thesis defense.

A thesis must be supervised by a faculty adviser selected by the student. Any full-time faculty member supporting the student's concentration area may serve as the thesis adviser. It is the student's responsibility either to find an adviser willing to provide a thesis topic or willing to supervise a topic of the student's choosing.

Once the student has found an adviser and a topic has been selected, the student and adviser should jointly form a thesis supervisory committee. This committee must consist of at least three members, two of whom must represent the concentration area. The adviser chairs this committee. The makeup of this committee must be approved by the chair of CSE and the director of the Graduate Division.

The student must provide the members of the committee with a written thesis proposal. Typically, this will be done before the faculty agrees to serve on the committee.

A thesis is judged by the supervisory committee based upon technical merit, originality and presentation. The thesis must be presented orally to the committee at a thesis defense. A copy of the thesis must be made available to each member of the committee at least two weeks before the planned defense. The defense must be scheduled with the CSE department office and posted in appropriate bulletin boards. The defense is open to the public.

Master of Science
(Major in Computer Science)

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for an M.S. degree, applicants are required to satisfy the following:

1. A Bachelor's degree in computer science, computer engineering or a closely related discipline. Applicants with undergraduate degrees in other disciplines may also be admitted to the program and may be required to take articulation coursework.
2. A minimum GPA of 3.0 on a 4.0 scale in the student's junior and senior years.
3. A reasonable level of mathematical maturity.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for an M.S. degree, candidates are required to satisfy the following:

1. Either 24 hours of coursework and a Master's thesis or 30 hours of coursework.
2. Twelve hours of core courses. Students on campus are required to register for a seminar course (for zero hours of credit) for at least one term and secure a grade of Pass.
3. Six hours of concentration. Thesis students take six hours of thesis, instead of concentration.
4. Twelve hours of electives. All students are allowed to take at most three hours of independent study, which will be counted as one elective course.

The CSE Department requires that the courses taken constitute a coherent program leading to mastery of computer science. These requirements are discussed in the subsequent subsections. Any deviation from the stated requirements must be approved in writing from the student's adviser and department chair.

Articulation

All students entering the program are expected to possess knowledge equivalent to the following CSE courses:

CSE 1341 Principles of Computer Science
CSE 1342 Programming Concepts
CSE 2341 Data Structures
CSE 2353 Discrete Computational Structures
CSE 3342 Programming Languages
CSE 3353 Fundamentals of Algorithms
CSE 3381 Digital Logic Design
CSE 4381 Digital Computer Design

Students with deficiencies may be granted conditional admission to the program and be required to take courses as articulation. Students are required to complete these articulation courses, maintaining a 3.0 average. The student who fails to achieve this record is automatically dropped from the graduate program, may not enroll in graduate courses and may be denied the right to petition for readmission. Students who maintain a 3.0 GPA in these courses may advance into the balance of their plan of study. As nearly as possible, these articulation courses should be completed before the courses in the balance of the plan of study are attempted. An articulation course must be completed before undertaking any graduate coursework, which requires it as prerequisite.

Residency and Level Requirements

A minimum of 30 graduate credits must be earned towards an M.S. degree, of which at least 24 must be earned in residency at SMU. Up to six credits may be transferred with departmental approval.

Of the 30 credit hours needed for graduation, at least nine credit hours must be at the 8000 level, with the remainder at the 7000 level or above.

Distribution of Courses

Courses are considered to be core, concentration or elective. Core courses cover material considered fundamental to graduate-level computer science and are required of all students. Each student is expected to specialize in some area of computer science. The concentration area is a mechanism by which a student can tailor a coherent program of study to his or her interests. Electives are courses

taken to round out the 30 credit hour requirement. Transferred credits may be used to satisfy any of these requirements. The specific requirements are discussed in detail in the following subsections.

Course Requirements

A student who elects to take the nonthesis option must take 12 hours of core courses, six hours of concentration and 12 hours of electives. Those who elect to take thesis option will substitute the concentration with thesis hours.

Core Courses (12 hours)

CSE 7330 File Organization and Database Management
CSE 7343 Operating Systems and System Software
CSE 7350 Algorithm Engineering
CSE 7381 Computer Architecture
CSE 8098 Computer Science Seminar

Concentration (6 hours in one of the following programs):

Algorithms (2 of the following)

CSE 7380 VLSI Algorithms
CSE 8350 Algorithms II
CSE 8351 Computer Arithmetic
CSE 8355 Graph Theory: Algorithms and Applications

Architecture (2 of the following)

CSE 7380 VLSI Algorithms
CSE 8377 Fault-Tolerant Computation
CSE 8380 Parallel and Distributed Processing
CSE 8383 Advanced Computer Architecture
CSE 8387 Switching Theory and Applications in VLSI CAD

Software (2 of the following)

CSE 7331 An Introduction to Data Mining and Related Topics
CSE 8313 Object-Oriented Analysis and Design Methodology
CSE 8330 Advanced Database Management Systems
CSE 8331 Data Mining
CSE 8337 Information Retrieval
CSE 8343 Advanced Operating Systems

Electives (12 hours)

CSE 7111 Intellectual Property and Information Technology
CSE 7314 Software Testing and Quality Assurance
CSE 7320 Artificial Intelligence
CSE 7330 File Organization and Database Management
CSE 7331 An Introduction to Data Mining and Related Topics
CSE 7341 Compiler Construction
CSE 7339 Computer System Security
CSE 7342 Concepts of Language Theory and Their Applications
CSE 7344 Computer Networks and Distributed Systems II
CSE 7345 Advanced Application Programming
CSE 7348 Internetworking Protocols and Programming
CSE 7349 Data and Network Security
CSE 7359 Software Security
CSE 7380 VLSI Algorithms
CSE 7382 Computer Graphics
CSE 7385 Microprocessor Architecture and Interfacing
CSE 7387 Digital Systems Design

CSE 8312 Software Generation and Maintenance
CSE 8313 Object-Oriented Analysis and Design
CSE 8314 Software Metrics and Quality Engineering
CSE 8316 User Interface Design
CSE 8317 Software Reliability and Safety
CSE 8320 Knowledge-Intensive Problem Solving
CSE 8321 Machine Learning and Neural Networks
CSE 8322 Natural Language Processing and Internet Applications
CSE 8325 Logic Programming
CSE 8330 Advanced Database Management Systems
CSE 8331 Data Mining
CSE 8337 Information Retrieval
CSE 8340 Advanced Topics in Software Engineering
CSE 8343 Advanced Operating Systems
CSE 8344 Computer Networks
CSE 8349 Advanced Network and System Security
CSE 8350 Algorithms II
CSE 8351 Computer Arithmetic
CSE 8355 Graph Theory: Algorithms and Applications
CSE 8358 Information Structures
CSE 8352 (EE 8372) Cryptography and Data Security
CSE 8377 Fault-Tolerant Computation
CSE 8380 Parallel and Distributed Processing
CSE 8383 Advanced Computer Architecture
CSE 8387 Switching Theory and Applications in VLSI CAD
EE 7356 VLSI Design and Lab
EE 8378 Performance Modeling and Evaluation of Computer Networks
EETS 8306 Wireless, Cellular and Personal Telecommunications
EETS 8307 Telecommunications Network Management
EETS 8322 Data Compression for Multimedia Application

Thesis Option

A student may elect to write a Master's thesis, which counts as the six hours of concentration. The student must register for at least six hours under CSE 7(1–6)96. If the thesis option is chosen, all other requirements are the same. The six hours of thesis satisfy six of the nine required hours for advanced courses.

A Master's thesis represents one or more of the following: synthesis of divergent ideas or a scholarly critique of current literature, a creative research activity or a significant design project, the results of which must be documented in a well-written thesis. The thesis should be of publishable quality, and it is recommended that it be submitted to an appropriate conference or journal before the thesis defense.

A thesis must be supervised by a faculty adviser selected by the student. Any full-time faculty member supporting the student's concentration area may serve as the thesis adviser. It is the student's responsibility to find an adviser willing to provide a thesis topic or willing to supervise a topic of the student's choosing.

Once the student has found an adviser and a topic has been selected, the student and adviser should jointly form a thesis supervisory committee. This committee must consist of at least three members, two of whom must represent the concentration area. The adviser chairs this committee. The makeup of this committee must be approved by the chair of CSE and the director of the Graduate Division.

The student must provide the members of the committee with a written thesis proposal. Typically, this will be done before faculty agrees to serve on the committee.

A thesis is judged by the supervisory committee based upon technical merit, originality and presentation. The thesis must be presented orally to the committee at a thesis defense. A copy of the thesis must be made available to each member of the committee at least two weeks before the planned defense. The defense must be scheduled with the CSE department office and posted on appropriate bulletin boards. The defense is open to the public.

Master of Science
(Major in Security Engineering)

Security engineering is the computer science and engineering discipline concerned with the design and development of secure systems and applications. Security engineering covers security of computer networks and systems as well as physical security. In addition to the technical aspects such as cryptography, protocols and access control, the curriculum deals with the policy and management issues, integration and logistics, and budgeting. Centering on the problems of working professionals in the critical field of security, the SMU program in security engineering serves the needs of both full-time and part-time students.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for an M.S. degree, applicants are required to satisfy the following:

1. A Bachelor's degree in one of the quantitative sciences, mathematics or computer science or in one of the engineering disciplines.
2. A minimum of one year of college-level calculus.
3. A minimum of one year of industry experience or submission of official GRE graduate school entry exam general test scores.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for an M.S. degree, candidates are required to satisfy the following:

1. Satisfactory completion of the core curriculum encompassing four courses:

   CSE 7339 Computer System Security
   CSE 7343 Operating Systems and System Software
   CSE 7349 Data and Network Security
   CSE 7359 Software Security

2. Satisfactory completion of three advanced elective courses from the following:

   CSE 7314 Software Testing and Quality Assurance
   CSE 7331 An Introduction to Data Mining and Related Topics
   EMIS 7340 Logistics Systems Engineering
   CSE 8316 User Interface Design
   CSE 8317 Software Reliability and Safety
   CSE 8331 Data Mining
   CSE 8349 Advanced Network Security
   EE 8372/CSE 8352 Cryptography and Data Security
   CSE 8377 Fault Tolerance

3. Satisfactory completion of three elective courses from available graduate-level course offerings in the Lyle School of Engineering and from the following list of special topic courses with approval from the program director or the department chair:

   CSE 8390 (Special Topics) Nano-Security
   CSE 8391 (Special Topics) Border and Transportation Security

Any deviation from the stated requirements must be approved in writing from the student's adviser and department chair.

Articulation

All students entering the program are expected to possess knowledge equivalent to the following CSE courses:

CSE 1341 Principles of Computer Science
CSE 1342 Programming Concepts
CSE 2341 Data Structures
CSE 2353 Discrete Computational Structures
CSE 3342 Programming Languages
CSE 3353 Fundamentals of Algorithms
CSE 4344 Computer Networks and Distributed Systems
CSE 4381 Digital Computer Design

Students entering the program with an undergraduate degree *other than computer science* will be asked to take an articulation course, CSE 5311 Fundamentals of Computer Science, to satisfy core competency in the core topic areas. CSE 5311 does not count toward the 30-hour degree requirement. Such students will receive conditional admission to the program. Students must receive a grade of *B* or better in CSE 5311 to continue in the program.

Master of Science
(Major in Software Engineering)

Software engineering is the computer science discipline concerned with developing large applications. Software engineering covers not only the technical aspects of building software systems, but also management issues.

The SMU Master's degree program in software engineering offers a balanced approach to management issues, such as directing programming teams, scheduling and budgeting, and technical expertise necessary to succeed in this critically important field. Many of the courses are based upon those proposed by the Software Engineering Institute, specifically founded by the Department of Defense to assist in the development of a sound foundation for this rapidly emerging field. Centering on the problems of working professionals in this field, the SMU program in software engineering serves the needs of both the full-time and part-time student.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for an M.S. degree, applicants are requsired to satisfy the following:

1. A Bachelor's degree in one of the quantitative sciences, mathematics or computer science or in one of the engineering disciplines.
2. A minimum of one year of college-level calculus.
3. A minimum of one year of experience in software development and/or maintenance.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for an M.S. degree, candidates are required to satisfy the following:

The program requires 30 hours of coursework consisting of 12 hours of core courses and 18 hours of electives as follows:

1. Satisfactory completion of the core curriculum encompassing four courses:

CSE 7314 Software Testing and Quality Assurance
CSE 7315 Software Project Planning and Management
CSE 7316 Software Requirements
CSE 7319 Software Architecture and Design

2. Satisfactory completion of three advanced elective courses from the following list:

CSE 7111 Intellectual Property and Information Technology
CSE 7340 Service-Oriented Computing
CSE 7345 Advanced Application Programming
CSE 7346 Distributed Java Enterprise Computing
CSE 7349 XML and the Enterprise
CSE 7357 Software Security
CSE 8312 Software Generation and Maintenance
CSE 8313 Object-Oriented Analysis and Design
CSE 8314 Software Metrics and Quality Engineering
CSE 8315 Software Acquisition Practices, Legal and Economic Issues
CSE 8316 User Interface Design
CSE 8317 Software Reliability and Safety
CSE 8340 Advanced Topics in Software Engineering

3. Satisfactory completion of three elective courses from available graduate-level course offerings.

Any deviation from the stated requirements must be approved in writing from the student's adviser and department chair.

Articulation

All students entering the program are expected to possess knowledge equivalent to the following CSE courses:

CSE 1341 Principles of Computer Science
CSE 1342 Programming Concepts
CSE 2341 Data Structures
CSE 2353 Discrete Computational Structures
CSE 3342 Programming Languages
CSE 3353 Fundamentals of Algorithms
CSE 4344 Computer Networks and Distributed Systems
CSE 4381 Digital Computer Design
CSE 5343 Operating Systems and Systems Software

These core topic areas form the basis of an undergraduate major in computer science. Students entering the program with an undergraduate degree *other than computer science* will be asked to take an articulation course, CSE 5311 Fundamentals of Computer Science, to satisfy core competency in the core topic areas. CSE 5311 does not count toward the 30-hour degree requirement.

Entering students without a background in object-oriented programming will be asked to take CSE 7345 Advanced Application Programming as one of their electives. CSE 7345 will count toward the 30-hour degree requirement.

CSE 5311 assumes the ability to program in Java or C++. Students who are asked to take CSE 5311 and who do not have a background in Java or C++ are advised to take CSE 7345 concurrently or prior to taking CSE 5311.

Students who do not have an undergraduate degree in computer science and who are asked to take CSE 5311 as an articulation course will receive conditional admission to the program. Students must receive a grade of *B* or better in CSE 5311 to continue in the program.

Doctor of Philosophy
(Major in Computer Engineering)

Students receiving a Ph.D. in computer engineering are expected to achieve and demonstrate a mastery of the discipline and to significantly advance the state of knowledge through an original research effort.

Admission Requirements

Applicants are required to satisfy the following:

1. An M.S. degree in computer engineering or a related field, including computer science, electrical engineering, mathematics or physics, from a U.S. college or university accredited by a regional accrediting association, or completion of an international degree that is equivalent to a U.S. Master's degree from a college or university of recognized standing. In the case of direct admission without a previous M.S. degree, the baccalaureate degree must be conferred prior to the time the student begins classes as a graduate student, and the student will fulfill the requirements for and obtain an M.S. degree and then continue working toward the Ph.D. Also, the student's GPA must be at least 3.4 on a 4.0 scale in the student's junior and senior years.
2. Excellent academic performance in all completed coursework, with a GPA of at least 3.0 on a 4.0 scale.
3. A reasonable level of mathematical maturity.
4. Submission of a complete application, including a statement of purpose, official transcripts for all previous undergraduate and graduate studies and payment of appropriate application fee.
5. Submission of official GRE graduate school entry exam general test scores.
6. Three letters of recommendation from individuals who can judge the applicant's potential success as a doctoral student.
7. Submission of a notarized financial certification form (graduates from foreign countries only). Before being considered for admission, all international students whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English proficiency exam score as follows:
   - 550 – paper-based examination.
   - 213 – computer-based examination.
   - 59 – Internet-based examination.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the Ph.D. degree, candidates are required to satisfy the following:

The graduation requirements fall into the categories of completion of a specified number of graduate credits in appropriate subjects with an acceptable GPA, demonstration of understanding of the discipline of computer engineering as evidenced by examination and completion of a substantial research effort documented in a doctoral dissertation.

All requirements must be completed within seven years of entry into the program.

The steps for completion of the doctoral program are:

1. Initial advising.
2. Basic coursework to prepare for the commencement of research work.
3. Selection of a research adviser and supervisory committee.

4. Advanced coursework in the chosen research area and guided thesis research to prepare for the qualifying examination.
5. Successful completion of the qualifying examination as determined by the doctoral advising committee.
6. Dissertation research supervised by the candidate's doctoral adviser.
7. Successful defense of the research leading to the Ph.D.

Any deviation from the stated requirements must be approved in writing from the student's adviser and department chair.

Initial Advising

Upon entry into the Ph.D. program, students are assigned a faculty adviser who acts as an academic adviser. The responsibilities of this adviser are to examine the student's prior background and current state of knowledge and to recommend courses to be taken in preparation for the commencement of research work.

Credit Requirements

All students entering the program are expected to possess knowledge equivalent to the following CSE courses:

CSE 1341 Principles of Computer Science
CSE 1342 Programming Concepts
CSE 2341 Data Structures
CSE 2240 Assembly Language Programming and Machine Organization
CSE 2353 Discrete Computational Structures
CSE 3342 Programming Languages
CSE 3353 Fundamentals of Algorithms
CSE 3381 Digital Logic Design
CSE 4344 Computer Networks and Distributed Systems
CSE 4345 Software Engineering Principles
CSE 4381 Digital Computer Design

A minimum of 54 graduate credits is required beyond the baccalaureate degree in order to achieve the Ph.D. degree. Of this, a minimum of 27 credit hours must be at the 8000 level. In addition to these 54 hours, 24 hours are required for dissertation credit. Of the 54 graduate credits, a maximum of 30 credit hours may transfer from an appropriate major from another institution. The following core courses must be taken at SMU if the student has not received credit for these at another university:

CSE 7343 Operating Systems and System Software
CSE 7344 Computer Networks and Distributed Systems II
CSE 7381 Computer Architecture
CSE 7387 Digital Systems Design

A minor, usually in an area of computer science, electrical engineering or mathematics, of a minimum of 12 credits supporting the chosen research area is required. These courses may be taken in CSE or a department separate from CSE. The minor requirement may be satisfied by transfer credit.

All full-time Ph.D. students in residence at the main campus of SMU may enroll in the CSE seminar class CSE 8098. The CSE 8098 course is graded on a pass/fail basis with a grade of Pass requiring the attendance of at least two-thirds of the CSE departmental seminars and distinguished speaker series. The seminar coordinator will keep attendance records.

Grades

No graduate credit is earned for a course in which a grade of less than *C-* is received. Such courses do, however, count toward the total GPA. A student must have a GPA of at least 3.0 on a 4.0 scale to graduate. If at any point a student's GPA drops below 3.0, the student is placed on academic probation. The student then has one term to raise his or her GPA to a minimum of 3.0 or be dismissed from the program. For part-time students, one term is taken to mean six credit hours. A grade of *I* (Incomplete) affects the GPA for the term in which the grade is granted rather than when it is removed; therefore, a student is placed on academic probation if he or she is granted a grade of *I* on currently completed work in the course and that grade causes the student's GPA to drop below 3.0.

Advanced Study

Advanced study in computer engineering consists of a major concentration area. A concentration area consists of a number of courses that are related to a specific sub-field of computer engineering. The major concentration consists of a minimum of 18 credits, no more than six of which can be independent study.

Credit earned for the core courses (CSE 7343, 7350, 7381 and 7387) will not be counted for the concentration area. The student must file an advanced study degree plan with the department. No degree plan is accepted until approved by the chair of CSE. Credits received prior to filing a degree plan are not guaranteed to count toward graduation.

Research Adviser and Supervisory Committee

Within two terms after joining the Ph.D. program, the student must find a research adviser and form a supervisory committee. It is the responsibility of the student to find a faculty member willing to provide a research topic or to supervise a topic of the student's choosing. The research adviser must be one of the full-time faculty members of the CSE Department. The research adviser, together with the student, should prepare the advanced study degree plan. They should also form the supervisory committee. The supervisory committee is made up of at least five members. Three resident tenured or tenure-track faculty members are drawn from the student's department, and one resident tenured or tenure-track faculty member is chosen from each minor field. The chair of the supervisory committee shall be a resident tenured or tenure-track member of the school faculty and shall normally be the dissertation director and a member of the student's department. Thus, a minimum of four members must be resident tenured or tenure-track faculty of SMU. The names of the supervisory committee members must be submitted to the chair of CSE and the director of the Graduate Division for approval.

Qualifying Examination

The student must complete all the core courses with an average grade of *B+* (3.3) or better before he or she can appear for the qualifying examination. The student will give a written proposal to the committee members. The timing of this submission will be determined by the thesis adviser and usually occurs at the 40–50 percent completion point of the thesis research.

Committee members will submit questions to the Ph.D. dissertation director. The director and the members will negotiate the content of the questions. The questions will generally be from areas related to the student's area of research and, hence, the questions will be submitted only after student has submitted the written proposal. However, should a majority of the committee judge that the student has not shown strong credentials in one or more of the core areas, the examination may include questions designed specifically to determine whether or not the student

has sufficient background in those areas. Examinations will be graded by each submitting member and given back to the chair. The chair, along with the other members, will decide the outcome (Pass/Fail) of the examination.

The written portion of the qualifying examination is a take-home (open-book) examination with four questions. Although there will be more than four members in the committee, usually one member will be from outside CSE and will not be required to submit a question. The student will have one week to answer questions and return the answers to the adviser. Each question is to be graded by the committee member who submitted that question. The student must attain an average score of 70 percent and a minimum score of 50 percent on each individual question in order to receive a passing grade.

After passing the written portion, the student will appear for the oral portion of the qualifying examination. In addition to evaluating the presentation based on the proposed research, the oral part will also address any deficiencies the written examination may reveal. The student should schedule the oral presentation at the time the written proposal is submitted, even though he or she will be eligible to appear for the oral presentation only after passing the written portion.

Students will have a maximum of two attempts to pass the qualifying examination.

If a student changes her or his area of research significantly, or if significant changes are made to the composition of the supervising committee, the student may be required to repeat the qualifying examination.

Change of Committee or Concentration

A student may change concentration, research adviser or supervisory committee at any point, subject to the approval of the CSE faculty. Such a change will generally require the formation of a new supervisory committee and will definitely require the filing of a new advanced study degree plan. The student must take a qualifying examination in the new concentration area to be admitted to candidacy. In the event that the student changes concentration after being admitted to candidacy, the candidacy is revoked and the student must pass the qualifying examination in the new concentration. Two attempts are allowed for a student in this position. A student may also change areas before being admitted to candidacy. In this event, it is possible that one or more unsuccessful attempts will have been made to pass the qualifying examination. The student may, at the discretion of the CSE supervisory committee, be allowed two attempts in the new concentration, but under no circumstances will more than three attempts be allowed at the examination. It is also possible that a student will change research adviser or composition of the supervisory committee, while still retaining the same concentration areas. Such changes may be made only with the approval of the CSE supervisory committee. If the research adviser is changed, the new research adviser may, at his or her discretion, require a new qualifying examination. In addition, if the makeup of the supervisory committee changes substantially, the CSE supervisory committee may require a new qualifying examination to be taken with the newly constituted committee.

Doctoral Dissertation

The most clearly distinguishing characteristic of a program leading to the Ph.D. degree is the requirement that the candidate write a dissertation embodying the results of a significant and original investigation. The dissertation must make a significant contribution to the engineering discipline, and it is expected to be a mature and competent piece of writing. The work reported in the dissertation may be either basic scientific research, engineering research or creative design.

Upon the successful completion of the dissertation defense, the dissertation is uploaded to the SMU/UMI Dissertation Publishing website. The original abstract must be signed by the dissertation adviser, and the original half-title page of the dissertation must be signed by all of the CSE faculty members attending the dissertation defense.

Dissertation Defense (Final Examination)

Upon completion of all other requirements, a dissertation defense by the candidate will be announced, registered with the Graduate Division and subsequently conducted by the supervisory committee. The candidate must make six unbound copies of his or her dissertation available to the members of the supervisory committee at least two weeks in advance of the dissertation defense. This defense, which is conducted orally, must enable the supervisory committee to satisfy itself that the dissertation is an original piece of work, either in research or creative design, that it has been carried out in keeping with the highest standards of investigation and reporting, and that it makes a contribution to knowledge that is of value to the engineering profession or scientific community. The defense must be scheduled with the CSE departmental office and posted in the Lyle School of Engineering. This defense is open to the public, with the possible exception of a period that involves general questions in computer science and engineering and that is open only to committee members and CSE faculty. Satisfactory performance on this defense constitutes the last requirement to be met for the Ph.D. degree.

Doctor of Philosophy (Major in Computer Science)

Students receiving a Ph.D. in computer science are expected to achieve and demonstrate a mastery of the discipline and to significantly advance the state of knowledge through an original research effort.

Admission Requirements

Applicants are required to satisfy the following:

1. An M.S. degree in computer science or a related field, including computer engineering, electrical engineering, mathematics or physics, from a U.S. college or university accredited by a regional accrediting association, or completion of an international degree that is equivalent to a U.S. Master's degree from a college or university of recognized standing. In the case of direct admission without a previous M.S. degree, the baccalaureate degree must be conferred prior to the time the student begins classes as a graduate student, and the student will fulfill the requirements for and obtain an M.S. degree and then continue working toward the Ph.D. Also, the student's GPA must be at least 3.4 on a 4.0 scale in the student's junior and senior years.
2. Excellent academic performance in all completed coursework, with a GPA of at least 3.0 on a 4.0 scale.
3. A reasonable level of mathematical maturity.
4. Submission of a complete application, including a statement of purpose, official transcripts for all previous undergraduate and graduate studies and payment of appropriate application fee.
5. Submission of official GRE graduate school entry exam general test scores
6. Three letters of recommendation from individuals who can judge the applicant's potential success as a doctoral student.
7. Submission of a notarized financial certification form (graduates from foreign countries only). Before being considered for admission, all international students

whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English proficiency exam score as follows:

- 550 – paper-based examination.
- 213 – computer-based examination.
- 59 – Internet-based examination.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the Ph.D. degree, candidates are required to satisfy the following:

The graduation requirements fall into the categories of completion of a specified number of graduate credits in appropriate subjects with an acceptable GPA, demonstration of understanding of the discipline of computer science as evidenced by examination, and completion of a substantial research effort documented in a doctoral dissertation.

All requirements must be completed within seven years of entry into the program.

The steps for completion of the doctoral program are:

1. Initial advising.
2. Basic coursework to prepare for the commencement of research work.
3. Selection of a research adviser and supervisory committee.
4. Advanced coursework in the chosen research area and guided thesis research to prepare for the qualifying examination.
5. Successful completion of the qualifying examination as determined by the doctoral advising committee.
6. Dissertation research supervised by the candidate's doctoral adviser.
7. Successful defense of the research leading to the Ph.D.

Any deviation from the stated requirements must be approved in writing from the student's adviser and department chair.

Initial Advising

Upon entry into the Ph.D. program, students are assigned a faculty adviser who acts as an academic adviser. The responsibilities of this adviser are to examine the student's prior background and current state of knowledge and to recommend courses to be taken in preparation for conducting research.

Credit Requirements

All students entering the program are expected to possess knowledge equivalent to the following CSE courses:

CSE 1341 Principles of Computer Science
CSE 1342 Programming Concepts
CSE 2240 Assembly Language Programming and Machine Organization
CSE 2341 Data Structures
CSE 2353 Discrete Computational Structures
CSE 3342 Programming Languages
CSE 3353 Fundamentals of Algorithms
CSE 3381 Digital Logic Design
CSE 4345 Software Engineering
CSE 4381 Digital Computer Design

A minimum of 54 graduate credits is required beyond the baccalaureate degree in order to achieve the Ph.D. degree. Of this, a minimum of 27 credit hours must be at the 8000 level. In addition to these 54 hours, 24 hours are required for

dissertation credit. Of the 54 graduate credits, a maximum of 30 credit hours may be used if an entering student possesses a M.S. in an appropriate major from another institution. The following core courses must be taken at SMU if the student has not received credit for these at another university:

CSE 7330 File Organization and Database Management
CSE 7343 Operating Systems and System Software
CSE 7350 Algorithm Engineering
CSE 7381 Computer Architecture

A minor, usually in an area of computer engineering, electrical engineering or mathematics, of a minimum of 12 credits supporting the chosen research area is required. These courses may be taken in CSE or in another department in the Lyle School of Engineering. The minor requirement may be satisfied by transfer credit.

All full-time Ph.D. students in residence at the main campus of SMU are required to enroll in the CSE seminar class CSE 8098. The CSE 8098 course is graded on a pass/fail basis with a grade of Pass requiring the attendance of at least two-thirds of the CSE departmental seminars and distinguished speaker series. The seminar coordinator will keep attendance records.

Grades

No graduate credit is earned for a course in which a grade of less than *C-* is received. Such courses do, however, count toward the total GPA. A student must have a GPA of at least 3.0 on a 4.0 scale to graduate. If at any point, a student's GPA drops below 3.0, the student is placed on academic probation. The student then has one term to raise his or her GPA to 3.0 or be dismissed from the program. For part-time students, one term is taken to mean six credit hours. A grade of *I* (Incomplete) affects the GPA for the term in which the grade is granted rather than when it is removed; therefore, a student is placed on academic probation if he or she is granted a grade of *I* on currently completed work in the course and that grade causes the student's GPA to drop below 3.0.

Advanced Study

Advanced study in computer science consists of a major concentration area. A concentration area consists of a number of courses that are related to a specific subfield of computer science. The major concentration consists of a minimum of 18 credits, no more than six of which can be independent study.

Credit earned for the core courses (CSE 7330, 7343, 7350 and 7381) will not be counted for the concentration area. The student must file an advanced study degree plan with the department. No degree plan is accepted until approved by the chair of CSE. Credits received prior to filing a degree plan are not guaranteed to count toward graduation.

Research Adviser and Supervisory Committee

Within two terms after joining the Ph.D. program, the student must find a research adviser and form a supervisory committee. It is the responsibility of the student to find a faculty member willing to provide a research topic or to supervise a topic of the student's choosing. The research adviser must be one of the full-time faculty members of the CSE department. The research adviser, together with the student, should prepare the advanced study degree plan. They should also form the supervisory committee. The supervisory committee is made up of at least five members. Three resident tenured or tenure-track faculty members are drawn from the student's department, and one resident tenured or tenure-track faculty member is drawn from each minor field. The chair of the supervisory committee shall be a resident

tenured or tenure-track member of the school faculty and shall normally be the dissertation director and a member of the student's department. Thus, a minimum of four members must be resident tenured or tenure-track faculty of SMU. The names of the members of the supervisory committee must be submitted to the chair of CSE and the director of the Graduate Division for approval.

Qualifying Examination

The student must complete all the core courses with an average grade of *B+* (3.3) or better before he or she can appear for the qualifying examination. The student will give a written proposal to the committee members. The timing of this submission will be determined by the thesis adviser and usually occurs at the 40–50 percent completion point of the thesis research.

Committee members will submit questions to the Ph.D. dissertation director. The director and the members will negotiate the content of the questions. The questions will generally be from areas related to the student's area of research and, hence, the questions will be submitted only after student has submitted the written proposal. However, should a majority of the committee judge that the student has not shown strong credentials in one or more of the core areas, the examination may include questions designed specifically to determine whether or not the student has sufficient background in those areas. Examinations will be graded by each submitting member and given back to the chair. The chair, along with the other members, will decide the outcome (Pass/Fail) of the examination.

The written portion of the qualifying examination is a take-home (open-book) examination with four questions. Although there will be more than four members in the committee, usually one member will be from outside CSE and will not be required to submit a question. The questions will be given to the students on a Friday as determined by the committee chair, and the answers will be due back on the following Friday. The student must attain an average score of 70 percent and a minimum score of 50 percent on each individual question in order to receive a passing grade.

After passing the written portion, the student will appear for the oral portion of the qualifying examination. In addition to evaluating the presentation based on the proposed research, the oral part will also address any deficiencies the written examination may reveal. The student should schedule the oral presentation at the time the written proposal is submitted, even though he or she will be eligible to appear for the oral presentation only after passing the written portion.

Students will have a maximum of two attempts to pass the qualifying examination.

If a student changes her or his area of research significantly or if significant changes are made to the composition of the supervising committee, the student may be required to repeat the qualifying examination.

Change of Committee or Concentration

A student may change concentration, research adviser or supervisory committee at any point, subject to the approval of the CSE faculty. Such a change will generally require the formation of a new supervisory committee and will definitely require the filing of a new advanced study plan. The student must take a qualifying examination in the new concentration area to be admitted to candidacy. In the event that the student changes concentration after being admitted to candidacy, the candidacy is revoked and the student must pass the qualifying examination in the new concentration. Two attempts are allowed for a student in this position. A student may also change areas before being admitted to candidacy. In this event,

it is possible that one or more unsuccessful attempts will have been made to pass the qualifying examination. The student may, at the discretion of the CSE supervisory committee be allowed two attempts in the new concentration, but under no circumstances will more than three attempts be allowed at the examination. It is also possible that a student will change research adviser or composition of the supervisory committee while still retaining the same concentration area. Such changes may be made only with the approval of the CSE supervisory committee. If the research adviser is changed, the new research adviser may, at his or her discretion, require a new qualifying examination. In addition, if the makeup of the supervisory committee changes substantially, the CSE supervisory committee may require a new qualifying examination to be taken with the newly constituted committee.

Doctoral Dissertation

The most clearly distinguishing characteristic of a program leading to the Ph.D. degree is the requirement that the candidate write a dissertation embodying the results of a significant and original investigation. The dissertation must make a contribution to knowledge that is of value to the computer science discipline, and it is expected to be a mature and competent piece of writing. The work reported in the dissertation may be either basic scientific research, engineering research or creative design.

Upon the successful completion of the dissertation defense, the dissertation is electronically uploaded to the SMU/UMI Dissertation Publishing submission website. The original abstract must be signed by the dissertation adviser, and the original half-title page of the dissertation must be signed by all of the CSE faculty members attending the dissertation defense.

Dissertation Defense (Final Examination)

Upon completion of all other requirements, a dissertation defense by the candidate will be announced, registered with the Graduate Division and subsequently conducted by the supervisory committee. The candidate must make six unbound copies of his or her dissertation available to the members of the supervisory committee at least two weeks in advance of the dissertation defense. This defense, which is conducted orally, must enable the supervisory committee to satisfy itself that the dissertation is an original piece of work, either in research or creative design, that it has been carried out in keeping with the highest standards of investigation and reporting, and that it makes a contribution to knowledge that is of value to the computer profession or scientific community. The defense must be scheduled with the CSE departmental office and posted in the Lyle School of Engineering. This defense is open to the public, with the possible exception of a period open only to committee members and CSE faculty in which general questions in computer science and engineering may be asked. Satisfactory performance on this defense constitutes the last requirement to be met for the Ph.D. degree.

Doctor of Engineering (Major in Software Engineering)

Students receiving a D.E. with a major in software engineering are expected to achieve and demonstrate a solid foundation and depth in software engineering practice, a breadth across the engineering discipline, and a significant and industrially relevant engineering innovative experience through the D.E. praxis.

Admission Requirements

Applicants are required to satisfy the following requirements:

1. A Master's degree in software engineering, computer science, computer engineering, engineering management or a related discipline.

2. Submission of official test scores from the GRE graduate school entry exam and submission of TOEFL English proficiency exam scores if English is not the applicant's native language.
3. Approval of the director of the software engineering program.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the D.E. degree, candidates are required to satisfy the following:

The graduation requirements fall into the categories of completion of a specified number of graduate credits in appropriate subjects and completion of a praxis:

1. Twenty-four credit hours of core software engineering courses. These hours must come from graduate-level courses in software engineering, as specified.
2. Twelve credit hours of core engineering management courses. These hours must come from graduate-level courses in engineering management, as specified.
3. Fifteen credit hours in a technical specialty. These hours must be taken in software engineering, computer science, computer engineering, engineering management, systems engineering or other technical areas consistent with anticipated doctoral work demands.
4. Fifteen credit hours of electives. All elective hours must come from graduate-level courses and must be approved by the advisory committee. These courses should, in some way, complement and strengthen the student's degree plan. They should broaden the student's understanding of the issues and problems relating to the application of software technologies to different engineering disciplines.
5. Twelve credit hours of praxis. These hours must be taken in residence. The student enrolls for these hours in the course of preparing the praxis project.

Any deviation from the stated requirements must be approved in writing from the student's adviser and department chair.

Core Courses in Software Engineering

The following courses or their equivalents must be included in the degree plan:

CSE 7316 Software Requirements
CSE 7319 Software Architecture and Design
CSE 7314 Software Testing and Quality Assurance
CSE 7315 Software Project Planning and Management

In addition, at least four of the following courses must be taken:

CSE 8312 Software Generation and Maintenance
CSE 8313 Object-Oriented Analysis and Design
CSE 8314 Software Metrics and Quality Engineering
CSE 8315 Software Acquisition Practices, Legal and Economic Issues
CSE 8316 User Interface Design
CSE 8317 Software Reliability and Safety
CSE 8340 Advanced Topics in Software Engineering

Core Courses in Engineering Management

The following courses, or their equivalents, must be included in the degree plan:

EMIS 7370 Probability and Statistics for Scientists and Engineers
EMIS 7377 Design and Analysis of Experiments

In addition, at least two of the following courses must be taken:

EMIS 8360 Operations Research Models
EMIS 8361 Economic Decision Analysis
EMIS 8364 Management for Engineers
EMIS 8378 Optimization Models for Decision Support

Praxis

The student must perform a suitable engineering praxis proposed by the student and approved by the praxis adviser and the supervisory committee. The praxis must include a significant and industrially relevant engineering innovative experience, typically revolving around a well-defined project relevant to current software engineering practice. Good scholarship and the significance of the student's praxis could be demonstrated by relevant technical publications, patents (or patent applications) or invention disclosures. As a culmination of the doctoral program, the student must submit an acceptable written praxis report and pass the oral praxis presentation and defense.

Upon the successful completion of the praxis defense, the praxis is uploaded to the SMU/UMI Praxis Publishing website. The original abstract must be signed by the praxis adviser, and the original half-title page of the praxis must be signed by all of the CSE faculty members attending the praxis defense.

Sample Doctoral Degree Plans

The courses comprising a degree plan for a D.E. with a major in software engineering will be determined by the student's supervisory committee. The plans will vary among students depending on their background and praxis topics. Sample degree plans cover both basic degree requirements and technical specialties.

Technical Specialty. All students must select a technical specialty track that is approved by their committee and that relates to their praxis topic. The following are *examples* of technical specialty tracks appropriate for D.E. with a major in software engineering candidates:

Security

CSE 7339 Computer System Security
CSE 7349 Data and Network Security
CSE 7359 Software Security
CSE 8349 Advanced Network and System Security
CSE 8352 Cryptography and Data Security
CSE 7348 Internetworking Protocols and Programming

Networks/Distributed Computing

CSE 7344 Computer Networks and Distributed Systems II
CSE 7346 Java Distributed Enterprise Computing
CSE 7348 Internetworking Protocols and Programming
CSE 8344 Computer Networks
CSE 8377 Fault-Tolerant Computation
CSE 8380 Parallel and Distributed Processing

Data Management

CSE 7330 File Organization and Data Management
CSE 7347 XML and the Enterprise
CSE 8330 Advanced Database Management Systems
CSE 7331 An Introduction to Data Mining and Related Topics
CSE 8331 Data Mining
CSE 8337 Information Retrieval

Embedded Systems

CSE 7380 VLSI Algorithms
CSE 7385 Microprocessor Architecture and Interfacing
CSE 8317 Software Reliability and Safety
CSE 8357 Design of CAD/CAE Tools
CSE 8387 Switching Theory and Applications in VLSI CAD
CSE 8388 Embedded Systems

High-Performance Applications Engineering (e.g., computer gaming)

CSE 7350 Algorithm Engineering
CSE 7381 Computer Architecture
CSE 7382 Computer Graphics
CSE 8355 Graph Theory: Algorithms and Applications
CSE 8351 Computer Arithmetic
CSE 8383 Advanced Computer Architecture

Recognition of Previous Post-Baccalaureate Coursework

Students with an M.S. in software engineering, engineering management or other related areas may apply up to 30 hours of their M.S. degree credits toward their D.E. with a major in software engineering, subject to approval of their supervisory committee.

Certificate Programs

Admission Requirements

Applicants are required to satisfy the following:

1. A Bachelor's degree in one of the quantitative sciences, mathematics, computer science, computer engineering or one of the other engineering disciplines from a U.S. college or university accredited by a regional accrediting association or completion of an international degree that is equivalent to a U.S. Bachelor's degree from a college or university of recognized standing. Applicants with undergraduate degrees in other disciplines may be admitted to the program on a conditional basis and required to take articulation (bridging) coursework (for undergraduate credit).
2. A minimum GPA of 3.0 on a 4.0 scale in previous undergraduate and graduate study.
3. Working knowledge of at least one programming language.
4. A minimum of one year of experience in software development and maintenance or computer networks.

Certificate Requirements

Applicants are required to complete the courses specified for the individual certificate with a grade of *B* or better.

Software Engineering Certificate Program

The software engineering certificate program presents a series of steps for acquiring basic software engineering knowledge and skills, followed by education in one or more specialty areas. Each certificate comprises selected Master's-level courses from the software engineering curriculum that can form the foundation of a later Master's degree.

Software Engineering Fundamentals (Required for all software engineering certificates)

CSE 7314 Software Testing and Quality Assurance
CSE 7315 Software Project Planning and Management
CSE 7316 Software Requirements
CSE 7319 Software Architecture and Design

Certificate in Software Engineering (Fundamental courses + the following)
CSE 7312 Software Systems Engineering
CSE 8313 Object-Oriented Analysis and Design

Certificate in Software Design Engineering (Fundamentals courses + the following)
CSE 8313 Object-Oriented Analysis and Design
CSE 8316 User Interface Design

Certificate in Software Construction Engineering (Fundamentals courses + the following)
CSE 8312 Software Generation and Maintenance
CSE 8313 Object-Oriented Analysis and Design

Certificate in Software Testing and Quality Engineering (Fundamentals courses + the following)
CSE 8314 Software Metrics and Quality Engineering
CSE 8317 Software Reliability and Safety

Certificate in Distributed Computing Technologies (Fundamentals courses + the following)
CSE 7346 Java Distributed Enterprise Computing
CSE 7347 XML and the Enterprise

Certificate in Software Management (Fundamentals courses + the following)
CSE 8314 Software Metrics and Quality Engineering
CSE 8315 Software Acquisition Practices, Legal and Economic Issues

Certificate Program in Computer Security and Information Assurance

The computer security and information assurance certificate program is designed for the computer and network professional seeking education to support focused career objectives in computer security and information assurance. A student will earn a certificate in computer security and information assurance upon completion of three courses from the following list:

CSE 7339 Computer System Security
CSE 7349 Data and Network Security
CSE 7359 Software Security
CSE 8349 Advanced Network and System Security
CSE 8352 (EE 8372) Cryptography and Data Security

The Courses (CSE)

7111. Intellectual Property and Information Technology. Fundamentals in the nature, protection and fair use of intellectual property. Patent, copyright, trademark, trade secret and antitrust principles with an emphasis on the Internet, software, databases and digital transmission technologies. The open source and creative commons alternatives for disseminating intellectual property. The engineer, scientist, manager and creative artist's professional and ethical responsibilities and opportunities regarding intellectual property. The rapid change in types and uses of intellectual property spawned by computers, digital media, e-commerce and biotechnology. *Prerequisite:* Graduate standing and a general understanding of software and digital information systems.

7312. Software Systems Engineering. The engineering of complex systems that have a strong software component. For such systems, software often assumes functions previously allocated to mechanical and electrical subsystems, changing the way systems engineers must think about classical systems issues. Provides a framework for addressing systems engineering issues by focusing on the Software Engineering Institute's Systems Engineering Capability Maturity Model. Includes deriving and allocating requirements, system and software architectures, integration, interface management, configuration management, quality, verification and validation, reliability, and risk.

7314. Software Testing and Quality Assurance. The relationship of software testing to quality with an emphasis on testing techniques and the role of testing in the validation of system requirements. Includes module and unit testing, integration, code inspection, peer reviews, verification and validation, statistical testing methods, preventing and detecting errors, selecting and implementing project metrics, and defining test plans and strategies that map to system requirements. Testing principles, formal models of testing, performance monitoring and measurement.

7315. Software Project Planning and Management. The issues associated with the successful management of a software development project. Includes planning, scheduling, tracking, cost and size, estimating, risk management, configuration, management quality, engineering, and process improvement. Focuses on the concept of a software engineering process and includes discussion of life-cycle models for software development. Includes the Software Engineering Institute Software Process Capability Maturity Model and other process standards.

7316. Software Requirements. Focuses on defining and specifying software requirements that can be used as the basis for designing and testing software. Includes use-cases for describing system behavior, formal methods, specifying functional vs. nonfunctional requirements, and the relationship of requirements to software testing.

7319. Software Architecture and Design. Successful software development requires both an understanding of software design principles and a broader understanding of software architectures that provide a framework for design. Explores the role of design in the software life cycle, including different approaches to design, design tradeoffs and the use of design patterns in modeling object-oriented solutions. Focuses on important aspects of a system's architecture, including the division of functions among system modules, synchronization, asynchronous and synchronous messaging, interfaces, and the representation of shared information.

7320. Artificial Intelligence. Introduction to basic principles and current research topics in artificial intelligence. Formal representation of real-world problems; search of problem spaces for solutions; and deduction of knowledge in terms of predicate logic, nonmonotonic reasoning and fuzzy sets. Application of these methods to important areas of artificial intelligence, including expert systems, planning, language understanding, machine learning, neural networks, computer vision and robotics. *Prerequisites:* CSE 3342 and CSE 2341.

7330. File Organization and Database Management. A survey of current database approaches and systems. Principles of design and use of these systems. Query language design and implementation constraints. Applications of large databases. Includes a survey of file structures and access techniques. Use of a relational database management system to implement a database design project. *Prerequisite:* CSE 2341.

7331. An Introduction to Data Mining and Related Topics. An introduction to data-mining topics. Emphasis on understanding concepts through an applied hands-on approach. All material covered will be reinforced through hands-on implementation exercises. Includes other related topics, such as data warehousing and dimensional modeling. *Prerequisite:* CSE 2341.

7335. Introduction to Bioinformatics. Covers the main fields in bioinformatics, including biological sequence analysis, computational structural biology, high-throughput microarray data analysis, proteomics data analysis, gene ontology, and gene and protein networks. *Prerequisites:* CSE 2341 and CSE 3353 or equivalent, or permission of instructor.

7339. Computer System Security. Investigates a broad selection of contemporary issues in computer security, including an assessment of state-of-the-art technology used to address security problems. Includes sources for computer security threats and appropriate reactions, basic encryption and decryption, secure encryption systems, program security, trusted operating systems, database security, network and distributed systems security, administering security, and legal and ethical issues. *Prerequisite:* CSE 5343 or equivalent.

7340. Service-Oriented Computing. Service-oriented computing is the computing paradigm that uses services as fundamental elements for developing applications. Service providers expose capabilities through interfaces. Service-oriented architecture maps these capabilities and interfaces so they can be orchestrated into processes. Fundamental to the service model

is the separation between the interface and the implementation, such that the invoker of a service need only (and should only) understand the interface; the implementation can evolve over time, without disturbing the clients of the service. *Prerequisites:* Graduate standing and programming experience.

7341. Compiler Construction. Review of programming language structures, loading, execution and storage allocation. Compilation of simple expressions and statements. Organization of a compiler including compile-time and run-time symbol tables, lexical analysis, syntax analysis, code generation, error diagnostics, and simple code optimization techniques. Use of a recursive high-level language to implement a complete compiler. *Prerequisites:* CSE 3342 and CSE 2341.

7342. Concepts of Language Theory and Their Applications. Introduction to formal languages and their relation to automata. Introduction to denotational and operational semantics. Applications of formal semantics to the design and specification of programming languages and programming language processors including computer architectures. The predicate calculus, logic programming and axiomatic semantics. Application of axiomatic semantics to the verification of programs. *Prerequisite:* CSE 3342 or permission of the instructor.

7343. Operating Systems and System Software. Theoretical and practical aspects of operating systems, including an overview of system software, time-sharing and multiprogramming operating systems; network operating systems and the Internet; virtual memory management; interprocess communication and synchronization; file organization; and case studies. *Prerequisite:* CSE 2341.

7344. Computer Networks and Distributed Systems II. Introduction to network protocols, layered communication architecture, multimedia applications and protocols, quality of service, congestion control, optical networks, dense wavelength division multiplexing, network survivability and provisioning, and wireless networks. Includes an interdisciplinary project requiring the use of currently available network design and simulation tools. *Prerequisite:* A grade of *C-* or better in CSE 4344.

7345. Advanced Application Programming. The course will cover advanced programming techniques that span a range of programming languages and technologies. Topics include server-side application development, client graphical user interface implementation, application frameworks, design patterns, model-based development and multithreading. The specific programming language or languages covered may vary from term to term. *Prerequisite:* CSE 3345 or consent of instructor.

7347. XML and the Enterprise. XML, the Extensible Markup Language, is widely used to define vocabularies for a wide range of applications, including software configuration, data exchange and Web-based protocols. Provides a detailed examination of XML as an enterprise technology. Focuses on APIs, interfaces and standards that are driving this technology, including DTDs and XML schema to structure SML data, XSLT to transform XML, XML protocols for distributed computing and XML security initiatives. Develops a broad understanding of XML and the technical issues and tradeoffs among different alternatives for processing XML. *Prerequisites:* An understanding of object-oriented concepts and familiarity with Java and/or C++.

7348. Internetworking Protocols and Programming. Processing and interprocess communications, UNIX domain sockets, fundamentals of TCP/IP, Internet domain sockets, packet routing and filtering and firewall, SNMP and network management, client-server model and software design, remote procedure call (XDR, RPC, DCE), design of servers and clients, networking protocols for the World Wide Web, and internetworking over new network technologies. *Prerequisites:* CSE 7343 and C programming.

7349. Data and Network Security. The course will cover conventional as well as state-of-the-art methods in achieving data and network security. Private key and public key encryption approaches will be discussed in detail with coverage on popular algorithms such as DES, AES and RSA. In the network security area, the course will cover authentication protocols, IP security, Secure Socket Layer, Web security and system level security. *Prerequisite:* CSE 7344 or equivalent with instructor permission.

7350. Algorithm Engineering. Algorithm design techniques. Methods for evaluating algorithm efficiency. Data structure specification and implementation. Applications to fundamental computational problems in sorting and selection, graphs and networks, scheduling and combinatorial optimization, computational geometry, and arithmetic and matrix computation. Introduction to parallel algorithms. Introduction to computational complexity and a survey of NP-complete problems. *Prerequisites:* CSE 3353 and CSE 2341 (for non-CSE graduate students: CSE 2341).

7356 (EE 7356). VLSI Design and Lab. Laboratory-oriented course for senior and Master's-level graduate students will cover an overview of IC circuit design and fabrication process, basic design rule, and layout techniques. Emphasis will be on digital design. CMOS and NMOS technology will be covered. Each student must complete one or more design projects by the end of the first term. *Prerequisites:* EE 2181, EE 2381 and EE 3311.

7359. Software Security. As software is delivered across networks and Web-based environments, security is critical to successful software deployment. Focuses on software security issues that pertain to the network application layer in the classic OSI model. At the application network layer, issues related to encryption, validation and authentication are handled programmatically rather that at the network level. Students will work with APIs for cryptography, digital signatures and third-party certificate authorities. Also explores issues related to XML and Web services security by examining standards and technologies for securing data and programs across collaborative networks. *Prerequisites:* Programming experience in Java and/or C++NS and CSE 7339.

7365 (MATH 5315). Introduction to Numerical Analysis. Numerical solution of linear and nonlinear equations, interpolation and approximation of functions, numerical integration, floating point arithmetic and the numerical solution of initial valve problems in ordinary differential equations. Emphasizes student use of the computer. *Prerequisites:* FORTRAN and MATH 2343 or 3315.

7366 (MATH 5316). Numerical Linear Algebra. The efficient solution of linear systems by both direct and interactive methods. Uses the concept of elementary matrix transformations to provide a unified treatment of direct methods. Develops stationary and conjugate direction methods for efficiently solving sparse linear systems. *Prerequisites:* FORTRAN or MATLAB, and MATH 3353, 3315 or 5315.

7370. Probability and Statistics for Scientists and Engineers. Introduction to fundamentals of probability and distribution theory, statistical techniques used by engineers and physical scientists. Examples of tests of significance, operating characteristic curves, tests of hypothesis about one and two parameters, estimation, analysis of variance and the choice of a particular experimental procedure and sample size. *Prerequisite:* MATH 2339 or equivalent.

7376 (EETS 7301). Introduction to Telecommunications. Overview of public and private telecommunications systems, traffic engineering, switching, transmission, and signaling. Channel capacity, media characteristics, Fourier analysis and harmonics, modulation, electromagnetic wave propagation and antennas, modems and interfaces, and digital transmission systems. TI carriers, digital microwave, satellites, fiber optics and SONET, and integrated services digital networks.

7380. VLSI Algorithms. Introduction to problems, algorithms and optimization techniques used in the design of high-performance very-large-scale integration design. Emphasis on algorithms for partitioning, placement, floor planning, wire routing and layout compaction. Additional focus on constraints for the design for field programmable gate arrays throughout the course. *Prerequisites: C-* or better in CSE 3381 and *C-* or better in CSE 2341.

7381. Computer Architecture. An advanced course introducing students to the state-of-the-art in uniprocessor computer architecture. Focuses on the quantitative analysis and cost performance tradeoffs in instruction-set, pipeline and memory design. Includes real systems and performance data, providing qualitative case studies that complement the quantitative analysis. Covers quantitative performance measures, pipelines, instruction-level parallelism, memory hierarchies, input/output, networks and parallel processors. *Prerequisites:* CSE 4381 and experience with both a high-level language and a hardware description language.

7382. Computer Graphics. Hardware and software components of computer graphics systems: display files, two-dimensional and three-dimensional transformations, clipping and windowing perspective, hidden line elimination and shaping, and interactive graphics and applications. *Prerequisite:* CSE 2341 or equivalent.

7385. Microprocessor Architecture and Interfacing. Emphasizes the design of microprocessor- and microcontroller-based computer systems. Starts with the presentation of microprocessor architecture and continues with the design of computer systems with hierarchical memory, input-output peripherals and industry-standard bus interfaces. This course includes a required laboratory with design projects in which students learn to use state-of-the-art CAD tools and laboratory instruments for hardware design, simulation, implementation and debugging. *Prerequisites:* CSE 3381 or EE 3380, and assembly language programming.

7387. Digital Systems Design. Modern topics in digital systems design, including the use of HDLs for circuit specification and automated synthesis tools for realization. Emphasizes the use of programmable logic devices. A heavy laboratory assignment content and a design project. *Prerequisite: C-* or better in CSE 3381 Digital Logic Design.

8098. Computer Science Seminar. Seminars and colloquia given by the resident faculty and invited guests in various specialized, as well as general, topics in computer science.

8312. Software Generation and Maintenance. Techniques for generating software and maintaining revisions to existing software. Includes alternatives to coding, the use of program generators and very high-level languages, CASE tool, component re-use and the role of standards in the generation of software. Also covered are issues related to maintenance as a part of software evolution, the impact of the design process on long-term software maintainability, software re-engineering and the planning of release cycles.

8313. Object-Oriented Analysis and Design. Object-oriented analysis and design is essential in developing high-quality object-oriented systems. Provides an overview of object-oriented analysis and design by integrating the work of Booch, Rumbaugh, Jacobson and Wirfs-Brock. Includes use-case analysis, responsibility-driven design, object modeling, entity-relationship modeling and the design notation of the Unified Modeling Language. Also object-oriented class libraries, object-oriented databases and the Common Object Request Broker Architecture.

8314. Software Metrics and Quality Engineering. Techniques of software quality engineering with emphasis on the role of metrics. The approach is drawn from practical experience and uses many examples from industry. Includes the psychological and behavioral aspects of quality and quality assurance. Presents metrics and quality in relationship to the software process and software process maturity models. Addresses selection of quality metrics in terms of the goal/question/metric paradigm as well as various quality models. Also, methods of storing data for historical purposes and analyzing and presenting data.

8315. Software Acquisition Practices, Legal and Economic Issues. Issues relating to software procurement, contract law, and specification and control of product processes. Includes factors that affect cost, cost estimation, cost/benefit analysis, risk analysis and legal implications with respect to ownership and use. Techniques and models of cost estimation studied in detail.

8316. User Interface Design. Design methodologies for user interfaces. Includes life cycles for user interface development, human factors issues, prototyping, user analysis and evaluation, and design techniques. Students will perform the analysis, design and evaluation of a user interface through two iterations.

8317. Software Reliability and Safety. In-depth study of techniques for ensuring software reliability and safety. Includes software reliability engineering, software safety engineering and recent developments in these areas. Reliability concepts applied to the software domain and safety concepts applied to computer-intensive systems. Specific techniques such as software reliability models and analysis methods, operational profiles, safety and hazard analysis using fault trees and event trees, and formal verification for safety-critical software systems.

8320. Knowledge-Intensive Problem Solving. Focuses on higher-level artificial intelligence techniques for problem-solving guided by domain-specific knowledge. Discusses these techniques via study of planning systems, heuristic rule-based systems, model-based systems and learning systems. *Prerequisite:* CSE 7320.

8321. Machine Learning and Neural Networks. Introduction to the principles and motivation behind forms of machine learning, including neural networks. Survey of important topics and current areas of research, including back propagation, Boltzmann machines, clustering, inductive learning, genetic learning and analogy. Strengths and weaknesses of each type of learning algorithm. *Prerequisite:* CSE 7320 or permission of the instructor.

8322. Natural Language Processing and Internet Applications. Covers state-of-the-art methods for natural language processing. After an introduction to the basics of syntax, semantic and discourse analysis, the focus shifts to the integration of these modules into complex natural-language processing systems. In addition to natural language understanding, presents advanced material on lexical knowledge acquisition, natural language generation, machine translation and parallel processing of natural language. *Prerequisite:* CSE 7320.

8325. Logic Programming. Explores logic-based computing and logic programming. Introduces fundamentals of logic programming and covers basic techniques for solving problems in Prolog, including nondeterministic programming, incomplete data structures, definite clause grammars and meta interpreters. Examines implementation of a logic programming system as a generalization of both traditional programming language systems and traditional databases. *Prerequisites:* CSE 3342 and 2341.

8330. Advanced Database Management Systems. An extensive investigation of distributed databases and implementation issues. Includes design, data replication, concurrency control and recovery. Implementation project. *Prerequisite:* CSE 7330.

8331. Data Mining. Examines advanced data mining topics, including temporal mining, Web mining, spatial mining and text mining. Case studies and projects. *Prerequisite:* CSE 7331.

8337. Information Retrieval. Examination of techniques used to store and retrieve unformatted/textual data. Also, current research topics in data mining, data warehousing, digital libraries, hypertext and multimedia data. *Prerequisite:* CSE 7330.

8340. Advanced Topics in Software Engineering. In-depth study of specific topics in software engineering techniques, methodologies and issues. Topics change from term to term and include advanced software reliability models, software development process models, advanced object-oriented design and cleanroom software engineering.

8343. Advanced Operating Systems. Theoretical and practical aspects of operating system design, implementation, system organization and resource management. Emphasis on distributed operating systems and advanced research issues. *Prerequisite:* CSE 7343.

8344. Computer Networks. Fundamentals of computer communications networks. Introduction to computer networking elements, communications architectures and protocols. Case studies. Design and analysis of computer networks: topology, LAN/MAN technology network interface, LAN/MAN performance internetworking and network management. *Prerequisite:* CSE 7344.

8349. Advanced Network and System Security. In-depth analysis of secure networks and systems, security audit, intrusion detection and prevention, storage security, firewall configurations, security log analysis, DMZs, honeypots, malicious codes, and mobile and grid computing security. *Prerequisite:* CSE 7349.

8350. Algorithms II. Analysis of dynamic data structures, lower-bound theory, problem equivalence and reducibility, complexity theory, probabilistic algorithms, machine models of sequential and parallel computation, and parallel algorithms. *Prerequisite:* CSE 7350.

8351. Computer Arithmetic. Number presentation and algorithms for arithmetic unit design, redundant radix representation, highly parallel add/multiply/divide/square root algorithms, IEEE floating-point standard, directed roundings, base conversion, VLSI floating-point units, vector and matrix arithmetic, residue arithmetic, rational arithmetic and online arithmetic. *Prerequisites:* Knowledge of computer organization, data structures and algorithms, as taught in CSE 2341.

8352 (EE 8372). Cryptography and Data Security. Cryptography is the study of mathematical systems for solving two kinds of security problems on public channels: privacy and authentication. Covers the theory and practice of both classical and modern cryptographic systems. The fundamental issues involved in the analysis and design of a modern

cryptographic system will be identified or studied. *Prerequisite:* STAT (CSE) 4340 or equivalent.

8354. Computational Biology. Math and computer science have changed the face of modern biological sciences and influenced a whole new field of computational biology (which is closely related to computational molecular biology and bioinformatics). Computational biology derives knowledge from algorithmic treatment and computer analysis of biological data. An introduction to the basic computational methods and algorithms used for the problems arising in biology. Covers sequence alignment problems using dynamic programming, hidden Markov models, suffix trees and heuristics. Focuses on the computational approaches to genetic and physical mapping, DNA sequencing, assembly, gene prediction, protein structure and folding, motif finding, gene regulatory networks and pathways, and evolutionary trees. *Prerequisite:* CSE 2341 or permission of the instructor.

8355. Graph Theory: Algorithms and Applications. Development of algorithmic and computational aspects of graph theory, with application of concepts and techniques to solving problems of connectivity, set covering, scheduling, shortest paths, traveling salesmen, network flow, matching and assignment. *Prerequisite:* CSE 7350 or permission of the instructor.

8357 (EE 8357). Design of CAD/CAE Tools. Concentrates on algorithm and software development techniques for design and implementation of CAD/CAE tools. Development of tools for VLSI and digital systems design. Includes database development to support design environments and representation, characteristics and design of synthesis, static analysis and dynamic analysis tools. Covers human interface issues and CAD/CAE output formats. *Prerequisite:* EE 7356 or experience with design using CAD/CAE tools and programming skills.

8358. Information Structures. A graduate-level data structures course that provides students a detailed hands-on examination of advanced data structures and their usage. During the first six weeks, covers advanced data structures, such as skip-lists, heaps, hash tables and search structures, and applies them in large problem-solving systems. During the following five weeks, covers classes, inheritance and polymorphism in large programming projects, as well as templates, and introduces the Standard Template Library. During the last three weeks, covers TCL and TK and teaches techniques of building interfaces using TCL and TK. Extensive programming assignments in C and C++. *Prerequisites:* CSE 2341 and CSE 3342.

8375 (EE 8375). Coding Theory and Applications. Information theory concepts, including measure of information, mutual information and entropy. Algebra, including groups, rings, finite fields and algebra of polynomials. Algebraic codes, including linear codes, cyclic codes and BCH codes. Fire codes, including encoding/decoding logic. Arithmetic codes, including AN codes, separate adder and checker. Applications to CSE 8320.

8377. Fault-Tolerant Computation. Faults, errors and failures, hardware fault tolerance, reliability, availability, reliable distributed systems, checkpointing and recovery, atomic actions data and process resiliency, software fault tolerance and case studies. *Prerequisite:* Permission of the instructor.

8380. Parallel and Distributed Processing. Parallel and distributed processing is a fast-growing technology that permeates many aspects of computer science and engineering. Emphasizes the strong interaction between parallel and distributed algorithms, architectures and software. Includes parallelism analysis in numeric and non-numeric algorithms, array processors, associative processors, multiprocessors, marker-propagation networks, distributed operating systems, networks of workstations, Internet computing and case studies. *Prerequisites:* Computer architecture and a high-level programming language.

8381. Quantum Logic and Computing. This course will provide a survey of quantum logic and quantum computing from the viewpoint of a computer engineer or computer scientist. The course will focus on issues of quantum logic circuit design, models of quantum computation and quantum computer algorithms. Existing and emerging circuit elements used to implement quantum logic circuits are surveyed. Principles of quantum mechanics as related to quantum computation will be introduced as the course proceeds. *Prerequisite:* Any one of CSE 7381, CSE 7385, EE 7381 or EE 7385, or consent of instructor.

8383. Advanced Computer Architecture. Advanced topics in computer architecture and parallel processing. *Prerequisites:* CSE 7381 and 7380.

8386. Testing of VLSI Circuits. The objective of testing is to verify that the manufactured custom chips function correctly according to their specifications. The testing process includes fault modeling, mainly automated simulation, test pattern generation, and testable and self-testing design synthesizing. Structured chips, such as memories, PLAs and FPGAs, are also tested for correctness. This course will survey the state-of-the-art test approaches used in industry and in other research environments. *Prerequisites:* Digital logic design, data structures and algorithms.

8387. Switching Theory and Applications in VLSI CAD. Advanced topics in switching theory and CAD methods. The underlying theory of the course topics is emphasized in addition to their application. Particular emphasis on the representation and properties of discrete functions and the syntheses and verification problems. In addition to the prerequisite, students are expected to have proficiency using a modern programming language. Previous exposure to an HDL will also be highly beneficial, but it is not a strict prerequisite. *Prerequisite:* CSE 7387 or equivalent.

8388. Embedded Computing System Design. Embedded systems are generally part of complex systems. An embedded system carries out the computational subtasks of the main system. The computing systems within home appliances and automobiles are examples of such systems. This course mainly will cover the process of embedded computing system design and consider cost, power, performance and several system-specific restrictions.

8389. Foundations of Formal Verification and Validation. Detecting and correcting integrated circuit design errors before device fabrication is an increasingly complex and costly problem. A large amount of effort is expended in the design verification and validation process in industry. This course will survey the most common approaches used in industry and in other research environments. Emphasizes tradeoffs between formal methods and validation techniques and the use of commercial state-of-the-art software tools. Includes equivalence checking, model checking, theorem proving and advanced topics in validation and simulation. *Prerequisite:* Programming languages, data structure, advanced digital logic design and computer architecture, or consent of the instructor.

8(0–9)9(0–3). Special Topics. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

8(1–9)9(4–5). Selected Problems. Independent investigation of topics in computer science approved by the department chair and by the major professor. *Prerequisite:* 12 term hours of graduate credit.

7(0,1,2,3,6)96. Master's Thesis. Variable credit, but not more than six term hours in a single term and not more than four in each summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, four term hours of thesis would require registration in CSE 7396 and CSE 7196.

8(0,1,2,3,6)96. Dissertation. Variable credit, but not more than 15 term hours in a single term and not more than 10 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of dissertation hours. For example, 12 term hours of dissertation would require registration in CSE 8396 and CSE 8996.

ELECTRICAL ENGINEERING

Associate Professor Marc P. Christensen, **Chair**

Professors: Jerome K. Butler, Scott C. Douglas, Delores M. Etter, Gary A. Evans, W. Milton Gosney, Alireza Khotanzad, Geoffrey C. Orsak, Panos E. Papamichalis, Behrouz Peikari. **Associate Professors:** Marc P. Christensen, Carlos E. Davila, James G. Dunham, Choon S. Lee, Sukumaran Nair, Dinesh Rajan, Mitchell A. Thornton. **Assistant Professors:** Joseph D. Camp, Ping Gui. **Senior Lecturer:** H. Charles Baker. **Visiting Assistant Professor:** Elisabeth A. Marley. **Adjunct Faculty:** Joseph R. Cleveland, Amitabh Dixit, Ahmed H'mimy, Hossam H'mimy, Shantanu Kangude, Clark Kinnaird, Richard Levine, Nhut Nguyen. ***Emeritus* Professors:** Kenneth L. Ashley, Robert R. Fossum, Someshwar C. Gupta, Lorn L. Howard, Mandyam D. Srinath.

The discipline of electrical engineering is at the core of today's technology-driven society. Personal computers, computer-communications networks, integrated circuits, optical technologies, digital signal processors and wireless communications systems have revolutionized the way people live and work, and extraordinary advances in these fields are announced every day. Because today's society truly is a technological society, graduate education in electrical engineering offers exceptional opportunities for financial security and personal satisfaction.

The Department of Electrical Engineering at SMU offers a full complement of courses at the Master's and Ph.D. level in communications, information technology, communication networks, digital signal processing, lasers and optoelectronics, electromagnetics and microwaves, microelectronics, VLSI design, systems and control, and image processing and computer vision. The courses and curriculum are designed and continuously updated to prepare the student for engineering research, design and development at the forefront of these fields.

A professionally oriented Master's degree in telecommunications systems is also offered through the Electrical Engineering Department, and courses in the curriculum (designated EETS) prepare the student for leadership roles in telecommunications systems management and planning and for developing new telecommunications products, services and applications.

Graduate Degrees

Master of Science in Electrical Engineering
Master of Science (Major in Telecommunications)
Doctor of Philosophy (Major in Electrical Engineering)

The SMU Electrical Engineering Department currently offers two graduate programs:

Master of Science in Electrical Engineering

The SMU Electrical Engineering Department emphasizes the following major areas of interest:

1. **Communications and Networking.** Detection and estimation theory, digital communications, computer and communication networks, cellular communications, coding, encryption, data compression, and wireless and optical communications.
2. **Signal Processing and Control.** Digital filter design, system identification, spectral estimation, adaptive filters, neural networks and digital signal processing implementations. Digital image processing, computer vision and pattern recognition. Linear and nonlinear systems, robotics, and computer and robot vision.
3. **Computer Engineering.** Electronic circuits, computer-aided design, VLSI design, neural network implementations, parallel array architectures and memory interfaces.
4. **Electromagnetics and Photonics.** Electromagnetic theory including microwave electronics, classical optics, metallic and dielectric wave-guides, antennas and transmission lines. Photonics including semiconductor lasers and detectors, active optical fibers and switches, integrated optics, fiber optics, photonic integrated circuits and optical backplanes.
5. **Electronic Materials, Devices and Microelectronics.** Fabrication and characterization of devices and materials, device physics, ultra-fast electronics and applications of the Scanning Tunneling microscope.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy this additional requirement:

Bachelor of Science degree in electrical engineering or a closely related discipline.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy additional requirements.

The plan of study involves these requirements:

1. Articulation courses, if necessary, are used to prepare a student for graduate study in electrical engineering (to bring the student's knowledge to the required level). Students must complete any required articulation courses with a GPA of 3.0 prior to entering the program.
2. All students must select a primary area and a secondary area from the areas listed in this section. A total of eight courses must be taken in these two areas with a minimum of four courses (12 term credit hours) in the primary area and a minimum of two courses (six term credit hours) in the secondary area.

Communication and Networking

EE 7370 Communication and Information Systems
EE 7375 Random Processes in Engineering
EE 7376 Introduction to Computer Networks
EE 7377 Wireless Communications and Lab
EE 8368 Signal Processing for Wireless Communications
EE 8370 Analog and Digital Communications
EE 8371 Information Theory
EE 8372 (CSE 8352) Cryptography and Data Security
EE 8375 Error Control Coding
EE 8376 Detection and Estimation Theory
EE 8377 Advanced Digital Communications
EE 8378 Performance Modeling and Evaluation of Computer Networks

Signal Processing and Control

EE 7345 Medical Signal Analysis
EE 7360 Analog and Digital Control Systems
EE 7362 (ME 7302) System Analysis
EE 7371 Analog and Digital Filter Design
EE 7372 Digital Signal Processing
EE 7373 DSP Programming Laboratory
EE 7374 Digital Image Processing
EE 7375 Random Processes in Engineering
EE 8364 Statistical Pattern Recognition
EE 8365 Adaptive Filters
EE 8366 Artificial Neural Networks
EE 8367 (ME 8367) Nonlinear Control
EE 8368 Signal Processing for Wireless Communications
EE 8373 Digital Speech Processing
EE 8374 Fundamentals of Computer Vision
EE 8376 Detection and Estimation Theory

Computer Engineering

EE 7340 Biomedical Instrumentation
EE 7356 VLSI Design and Lab
EE 7357 CAE Tools for Structured Digital Design
EE 7380 Logic and Design Implementation
EE 7381 Digital Computer Design
EE 7385 Microprocessors in Digital Design
EE 8356 Advanced Topics in VLSI Design
EE 8357 (CSE 8357) Design of CAD/CAE Tools
EE 8382 Digital Signal Processing Architectures
EE 8385 Microprocessor Architecture and Interfacing

Electromagnetics and Optics

EE 7332 Electromagnetics: Radiation and Antennas
EE 7333 Antennas and Radiowave Propagation for Personal Communications
EE 7336 Introduction to Integrated Photonics
EE 8322 Semiconductor Lasers
EE 8325 Optical Radiation and Detectors
EE 8331 Microwave Electronics
EE 8332 Numerical Techniques in Electromagnetics
EE 8333 Advanced Electromagnetic Theory

Electronic Materials, Devices and Microelectronics

EE 7310 Introduction to Semiconductors
EE 7312 Semiconductor Processing Laboratory
EE 7314 (ME 7314) Introduction to Microelectromechanical Systems (MEMS) and Devices
EE 7321 Semiconductor Devices and Circuits
EE 8310 Electronic Processes
EE 8322 Semiconductors Lasers
EE 8325 Optical Radiation and Detectors
EE 8328 Semiconductor Devices
EE 8355 Transistor Integrated Circuits

3. Students must also take two minor courses (six term credit hours) from graduate offerings in electrical engineering, electrical engineering telecommunications specialization, mechanical engineering, computer science engineering, environmental and civil engineering, math, physics, statistics, biology, chemistry, geological sciences, or business. These are completely free electives with no restrictions as to their relevance to the primary/secondary areas or to each other.
4. At least three of the EE courses (nine term credit hours) must be graduate courses numbered 8000. EETS courses do not count toward this requirement.
5. An optional Master's thesis may be substituted for two of the eight primary/secondary courses and count toward the 8000 level requirement.
6. The student should file a degree plan of study with the help of his or her adviser as soon as possible after admission, but no later than the end of the second term after matriculation. Courses not listed on the degree plan of study should not be taken without the approval of the adviser. If the degree plan of study is altered, the student must go through the approval process again.

Master of Science in Electrical Engineering (Telecommunications Specialization)

The Department of Electrical Engineering offers a large number of courses in telecommunications. For students interested in this area, the department offers a telecommunications specialization under the M.S.E.E. degree program. While students

in the M.S.E.E program are required to take 12 term credit hours of core courses in a primary area and can take courses outside the Electrical Engineering Department as minor courses, students in the telecommunications specialization are required to take five core courses related to telecommunications and five elective courses.

Core Courses

EE 7370 Communication and Information Systems
EE 7372 Digital Signal Processing
EE 7375 Random Processes in Engineering
EE 7376 Introduction to Computer Networks
EE 8370 Analog and Digital Communications

Elective Courses

A student may take five courses from graduate EE and EETS course offerings in the Electrical Engineering Department, of which no more than three can be EETS courses. However, EETS 7301 and EETS 7302 cannot be used toward this degree. A thesis may be substituted for three to six term credit hours of elective coursework.

Master of Science (Major in Telecommunications)

Telecommunications provides corporate management with many new opportunities for enhancing efficiency and improving profits. Rapid advances in technology and changes in the regulatory climate have made major impacts in the telecommunications industry. A host of new products, services and applications are creating alternatives in carriers, equipment and networks.

In recognition of the critical need for professional education in this field, the Lyle School of Engineering offers programs oriented toward the management of corporate communications and the design of telecommunication products and systems. This program is offered both on- and off-campus via remote delivery systems. The Master's degree may be completed via DVD. See the Off-Campus Distance Education section for more information regarding off-campus delivery systems.

This program is intended for students interested in employment with a corporate telecommunications management group or with a vendor, carrier, regulatory agency, research or consulting firm. Students who have an undergraduate degree in electrical engineering and are interested in design and implementation of telecommunications systems may find the M.S.E.E. with telecommunications specialization more appropriate for their needs. This program leads to a professional degree and does not qualify for admission into the electrical engineering program to study toward the Ph.D. degree.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a M.S. degree, applicants are required to satisfy these additional requirements:

1. Bachelor of Science in one of the sciences, mathematics or computer science or in one of the engineering disciplines.
2. Bachelor's degree in liberal arts or business with additional background in differential and integral calculus and physics.
3. Computer programming experience.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy these additional requirements:

Satisfactory completion of the core curriculum encompassing three courses:

EETS 7301 Introduction to Telecommunications
EETS 7304 Internet Protocols
EETS 7315 Data Communication

Satisfactory completion of seven other courses from the list of advanced electives and additional electives:

Advanced Electives

EETS 7302 Telecommunication Management and Regulation
EETS 7303 Fiber Optic Telecommunications
EETS 7306 Wireless, Cellular and Personal Telecommunications
EETS 7320 Digital Telecommunications Technology
EETS 8305 Telecommunications Software Design
EETS 8307 Telecommunications Network Management
EETS 8311 Intelligent Networks
EETS 8313 Internet Telephony
EETS 8315 Advanced Topics in Wireless Communication
EETS 8316 Wireless Networks
EETS 8317 Switching and QoS Management in IP Networks
EETS 8318 Wireless Internet
EETS 8319 Optical DWDM Networks
EETS 8321 Telecommunications Network Security
EETS 8322 Data Compression for Multi-Media Applications

Additional Electives

EE 7370 Communication and Information Systems
EMIS 7370 Statistics for Engineers
EMIS 8361 Economic Decision Analysis
EMIS 8362 Engineering Accounting
EMIS 8363 Engineering Finance
EMIS 8364 Management for Engineers

The department offers a wireless concentration under the Master of Science (major in telecommunications) program. The requirements for the program are:

CORE Courses

EETS 7301 Introduction to Telecommunications
EETS 7304 Internet Protocols
EETS 7315 Data Communications

Wireless Concentration

EETS 7306 Wireless, Cellular and Personal Communications
EETS 8315 Advanced Topics in Wireless Communication
EETS 8316 Wireless Networks
EETS 8318 Wireless Internet

Electives

Any three courses from the list of advanced or additional electives.

Doctor of Philosophy (Major in Electrical Engineering)

Admission Requirements

1. Master of Science degree in electrical engineering or in a closely related discipline from a U.S. college or university accredited by a regional accrediting association or completion of an international degree that is equivalent to a U.S. Master's degree from a college or university of recognized standing.

2. Excellent academic performance in all completed coursework, with a minimum GPA 3.0 on a 4.0 scale.
3. Submission of a complete application, including a statement of purpose, official transcripts for all previous undergraduate and graduate studies and payment of appropriate application fee.
4. Official GRE graduate school entry exam quantitative score of 650 or greater.
5. Three letters of recommendation from individuals who can judge the applicant's potential success as a doctoral student.
6. Graduates from foreign countries are required to submit a notarized financial certification form. All international students whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English language proficiency score before being considered for admission:
   - 550 – paper-based examination.
   - 213 – computer-based examination.
   - 59 – Internet-based examination.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the Ph.D. degree, candidates are required to satisfy the following:

Supervisory Committee

The supervisory committee plays an important role in guiding the student and monitoring his or her progress at all stages of the Ph.D. program. As such, the committee should be constituted as early as possible after the student has begun doctoral work and before he or she has completed the coursework. The committee will be selected by the student in consultation with the dissertation director, who must be a member of the regular (tenure-track) faculty of the Electrical Engineering Department. The committee chair must be a member of the regular faculty of the department and will normally be the dissertation director. The committee must have a minimum of five members of the regular faculty of the University and will consist of at least three faculty members from the Electrical Engineering Department (including the chair and the dissertation director, if different from the chair), as well as one member from each minor field.

Qualifying Examination

The qualifying examination for admission to candidacy for the Ph.D. degree consists of both written and oral parts. The written part will be administered by the doctoral program committee of the Electrical Engineering Department and will normally be given once each fall and spring term on dates to be announced by the committee. The exam must be taken no later than one year after the student begins the Ph.D. program, or at the earliest time thereafter that the exam is scheduled. The exam is based on coursework in the student's major area. A student who desires to take the written exam in any term must file a registration form with the doctoral program committee prior to the deadline specified each term. The student is required to pass the exam in one area to be chosen from the list below:

- Digital Signal Processing.
- Communications.
- Systems and Control.
- Electromagnetic Theory and Optics.
- Solid-State Devices and Materials.
- Circuits.

Each exam will be three hours in duration and will typically be closed-book. The determination as to whether a student has passed the written exam will be made by the doctoral program committee.

1. A student who does not pass the exam can take it a second time.
2. A student who fails the exam both times will not be permitted to continue in the Ph.D. program.
3. A student who repeats an exam must do so at the earliest possible time after the first attempt.
4. If, after passing the written exam, the student decides to change his or her research area, he or she will be required to pass another written exam in the new area.

The oral qualifying exam will be administered by the student's supervisory committee. The exam will be taken after the student has passed the written exam and has completed most of the required coursework, but no later than one year after completing all coursework. A student who does not meet the deadline must petition the doctoral program committee for permission to take the oral exam.

The main focus of the oral exam will be on the research the student proposes to conduct for his or her dissertation. The student is expected to write up a description of the research problem, previous results and the approach or approaches he or she proposes to consider in the investigation. The write-up must be made available to the supervisory committee at least two weeks prior to the scheduled date of the exam and should clearly indicate the significance and originality of the research, the proposed approaches and the expected results.

The student will be admitted to candidacy upon passing the oral qualifying exam. A student who does not pass the oral exam may be permitted by the supervisory committee to retake it once. If, after admission to candidacy, the student decides to change his or her research area, he or she will be required to take the qualifying exam again and be readmitted to candidacy before being permitted to complete the dissertation.

Final Examination

Upon completion of all other requirements, the student is required to take a final examination conducted by his or her supervisory committee, in which he or she will present the dissertation. The student will notify the Lyle School of Engineering Graduate Division in advance of the date, time and place of the exam so that it can be publicized on campus. The student should provide copies of the complete draft version of the dissertation to the supervisory committee at least three weeks prior to the date of the final exam. It is recommended that students submit the results of their research for publication at conferences or in journals before taking the final exam.

The supervisory committee may ask questions and make comments or require changes in the dissertation to satisfy itself that the quality of the work is in keeping with the highest standards of research. If the dissertation requires substantial changes, the student should submit the revised dissertation to the supervisory committee for re-examination.

Department Facilities

The Electrical Engineering Department is housed in the Jerry R. Junkins Electrical Engineering Building. The building contains teaching classrooms and laboratories, as well as space for faculty offices and the EE department staff and operations.

The department has access to the Lyle School of Engineering academic computing resources, consisting of shared use computer servers and desktop client systems connected to a network backbone. All of the servers in the Lyle School of Engineering are running some variant of UNIX or Microsoft Windows. There is one primary file server that holds 356 GB of data and exports files using FNS or CIFS protocols. Each user, whether faculty, staff or student, has a "home" directory on the central file server. This directory is exported to other servers or desktop computers, regardless of operating systems, as needed. There are more than 40 servers with purposes that include: file service, UNIX mail, Exchange mail, firewall, UNIX authentication, NT authentication, printer management, lab image download, classroom-specific software, X windows service, news, domain name service, computational resources and general use. This allows the files to be used as a resource in both the UNIX and Microsoft PC environments. Almost all computing equipment within the Lyle School of Engineering is connected to the engineering network at 100 megabits and higher. The network backbone is running at a gigabit per second over fiber. Most servers and all engineering buildings are connected to this gigabit backbone network. The backbone within engineering is connected to both the Internet 2 and the campus network that is then connected to the Internet at large. In addition to servers and shared computational resources, the Lyle School of Engineering maintains a number of individual computing laboratories associated with the engineering departments.

Instructional and Research Facilities

Antenna Lab. The antenna lab consists of two facilities for fabrication and testing. Most of the antennas fabricated at the SMU antenna lab are microstrip antennas. Small and less complex antennas are made with a T-Tech milling machine, and a photolithic/chemical etching method is used to make more complex and large antennas. Fabricated antennas are characterized with an HP 5810B network analyzer. Workstations are available for antenna design and theoretical computation. Radiation characteristics are measured at the anechoic chamber at the University of Texas at Arlington under a contractual agreement.

Biomedical Engineering Laboratory. This laboratory contains instrumentation for carrying out research in electrophysiology, psychophysics and medical ultrasound. Four Grass physiographs permit the measurement of electroencephalograms as well as visual and auditory evoked brain potentials. The lab also contains a state-of-the-art dual Perkinje eye tracker and image stabilizer made by Fourward Technologies Inc., a Vision Research Graphics 21-inch Digital Multisync Monitor for displaying visual stimuli and a Cambridge Research Systems visual stimulus generator capable of generating a variety of stimuli for use in psychophysical and electrophysiological experiments. Ultrasound data can also measured with a Physical Acoustics apparatus consisting of a water tank, RF pulser/receiver and RF data acquisition system. Several PCs are also available for instrumentation control and data acquisition.

Digital Signal Processing Laboratory. Digital signal processors are programmable semiconductor devices that are used extensively in cellular telephones, high-density disk drives and high-speed modems. Courses in this laboratory focus on programming the Texas Instruments TMS320VC510, a fixed-point processor, with emphasis on assembly language programming. Topics include implementation of FIR and IIR filters, the FFT and a real-time spectrum analyzer.

Networks Laboratory. The Networks Laboratory provides the opportunity to simulate and evaluate different network configurations from local area networks to the Internet. High-end PCs are configured with OPNET and mathematics software to model telecommunications networks and study their performance. The Networks

Laboratory is used for instruction in conjunction with several networking courses offered in the department.

Multimedia Systems Laboratory. This facility includes an acoustic chamber with adjoining recording studio to allow high-quality sound recordings to be made. The chamber is sound-isolating with double- or triple-wall sheet rock on all four sides as well as an isolating ceiling barrier above the drop ceiling. The walls of the chamber have been constructed to be nonparallel to avoid flutter echo and dominant frequency modes. Acoustic paneling on the walls of the chamber are removable and allow the acoustic reverberation time to be adjusted to simulate different room acoustics. The control room next to the acoustic chamber includes a large 4-foot-by-8-foot acoustic window and inert acoustic door facing the acoustic chamber. Up to sixteen channels of audio can be carried in or out of the chamber to the control room. Experiments to be conducted in the Multimedia Systems Laboratory include blind source separation, deconvolution and dereverberation. Several of the undergraduate courses in electrical engineering use sound and music to motivate system-level design and signal processing applications. The Multimedia Systems Laboratory will be used in these activities to develop data sets for use in classroom experiments and laboratory projects for students to complete.

High-Speed Wireless Communications Laboratory. The laboratory provides a multitier network test bed for research purposes and also serves as a facility for conducting lab courses on wireless communications and networking. The infrastructure in the lab includes: a) GSM-based cellular network that provides wide range connectivity at medium data rates, b) 802.11-based WLAN offering high data rates in an office environment and c) Bluetooth networks that offer low-cost, short-range and low data rate connections. One of the research focus areas is investigation of total power efficiency of these heterogeneous networks.

Semiconductor Processing Cleanroom. The 2,800 square-foot, class 10,000 cleanroom, consisting of a 2,400 square-foot, class 10,000 room and a class 1000 lithography area of 400 square feet, is located in the Jerry R. Junkins Engineering Building. A partial list of equipment in this laboratory includes acid and solvent hoods, photoresist spinners, a scanning electron microscope, two contact mask aligners, a thermal evaporator, a plasma asher, a plasma etcher, a turbo-pumped methane hydrogen reactive ion etcher, a four-target sputtering system, a plasma-enhanced chemical vapor deposition reactor, a diffusion-pumped four pocket e-beam evaporator, an ellipsometer and a profilometer. Other equipment includes a boron-trichloride reactive ion etcher, a chemical-assisted ion-beam etcher and an e-beam evaporator for dielectric deposition. The cleanroom is capable of processing silicon and compound semiconductors for microelectronic, photonic and nanotechnology devices.

Submicron Grating Laboratory. This laboratory is dedicated to holographic grating fabrication and has the capability of sub tenth-micron lines and spaces. Equipment in this laboratory includes a floating air table, an argon ion laser (ultraviolet lines) and an Atomic Force Microscope. This laboratory is used to make photonic devices with periodic features such as distributed feedback, distributed Bragg reflector, and grating-outcoupled and photonic crystal semiconductor lasers.

Photonic Devices Laboratory. This laboratory is dedicated to characterizing the optical and electrical properties of photonic devices. Equipment in this laboratory program includes optical spectrum analyzer, an optical multimeter, visible and infrared cameras, an automated laser characterization system for edge-emitting lasers, a manual probe test system for surface-emitting lasers, a manual probe test system for edge-emitting laser die and bars, and a near- and far-field measurement system.

Photonics Simulation Laboratory. This laboratory has specific computer programs that have been developed and continue to be developed for modeling and designing semiconductor lasers and optical waveguides, couplers and switches. These programs include WAVEGUIDE, which calculates near-field, far-field and effective indices of dielectric waveguides and semiconductor lasers with up to 500 layers. Each layer can contain gain or loss: GAIN (calculates the gain as a function of energy, carrier density and current density for strained and unstrained quantum wells for a variety of material systems), GRATING (uses the Floquet Bloch approach and the boundary element method to calculate reflection, transmission and outcoupling of dielectric waveguides and laser structures with any number of layers) and FIBER (calculates the fields, effective index, group velocity and dispersion for fibers with a circularly symmetric index of refraction profiles). Additional software is under development to model the modulation characteristics of photonic devices.

Photonic Architectures Laboratory. This laboratory has a fully equipped optomechanical and electrical prototyping facility, supporting the activities of faculty and graduate students in experimental and analytical tasks. The lab will be ideally suited for the packaging, integration and testing of devices, modules and prototypes of optical systems. It will have two large vibration isolated tables, a variety of visible and infrared lasers, single element 1-D and 2-D detector arrays and a large compliment of optical and optomechanical components and mounting devices. In addition, the laboratory will have extensive data acquisition and analysis equipment, including a 1394 (Firewire) capable image capture and processing workstation, specifically designed to evaluate the electrical and optical characteristics of smart pixel devices and FSOI modules. Support electronics hardware will include various test instrumentation, such as arbitrary waveform generators and a variety of CAD tools for optical and electronic design.

The Courses (EE)

For EE courses, the third digit in the course number designator indicates the subject area represented by the course. The courses for the Master's degree in telecommunications are indicated by the prefix EETS. The EETS course descriptions are listed following the EE courses. The following designators are used for EE courses:

XX1X Electronic Materials
XX2X Electronic Devices
XX3X Quantum Electronics and Electromagnetic Theory
XX4X Biomedical Science
XX5X Network Theory and Circuits
XX6X Systems
XX7X Information Science and Communication Theory
XX8X Computers and Digital Systems
XX9X Individual Instruction, Research, Seminar and Special Project

7(1–3)9(0–9). Special Topics. This special topics course must have a section number associated with a faculty member. The second digit corresponds to the number of term credit hours, which ranges from one to three term credit hours. The last digit ranges from zero to nine and represents courses with different topics.

7310. Introduction to Semiconductors. A study of basic principles in physics and chemistry of semiconductors that have direct applications on device operation and fabrication. Includes basic semiconductor properties, elements of quantum mechanics, energy band theory, equilibrium carrier statistics and carrier transport, and generation-recombination processes. A study of devices including metal-semiconductor junctions, p-n junctions, LEDs, semiconductor lasers, bipolar junction transistors, field-effect transistors and integrated circuits. An

emphasis on obtaining the governing equations of device operation based on physical principles. *Prerequisite:* EE 3311 or equivalent, graduate standing or permission of instructor.

7312. Semiconductor Processing Laboratory. A laboratory-oriented elective course for senior and first-year graduate students providing in-depth coverage of processing of InP and GaAs compounds in addition to silicon integrated circuit processing. Students without fabrication experience will fabricate and characterize MOSFETS and semiconductor lasers. Students with some previous fabrication experience (such as EE 3311) will fabricate and test an advanced device mutually agreed upon by the student(s) and the instructor. Examples of such devices include High Electron Mobility Transistors, Heterojunction Bipolar Transistors, phase shifters, distributed Bragg reflector lasers, grating assisted directional couplers and semiconductor lasers from developing materials such as GaInNAs. The governing equations of photolithography, oxidation, diffusion, ion-implantation, metalization and etching will be derived from fundamental concepts. Silicon process modeling will use the CAD tool SUPREM. Optical components will be modeled using the SMU developed software WAVEGUIDE, GAIN and GRATING. A laboratory report describing the projects will be peer-reviewed before final submission. *Prerequisite:* EE 3311 or equivalent, graduate standing or permission of instructor. EE 7310 recommended but not required.

7314 (ME 7314). Introduction to Microelectromechanical Systems (MEMS) and Devices. The basics for microelectromechanical devices and systems, including microactuators, microsensors and micromotors, principles of operation, different micromachining techniques (surface and bulk micromachining), IC-derived microfabrication techniques and thin-film technologies as they apply to MEMS. *Prerequisite:* EE 3311 or permission of instructor.

7321. Semiconductor Devices and Circuits. A study of the basics of CMOS integrated analog circuits design. Topics include MOSFET transistor characteristics, DC biasing, small-signal models, different amplifiers, current mirrors, single- and multistage electronic amplifiers, frequency response of electronic amplifiers, amplifiers with negative feedback and stability of amplifiers. Each student will complete one or more design projects by the end of the course. *Prerequisites:* EE 3122 and EE 3322.

7330. Electromagnetics: Guided Waves. Application of Maxwell's equations to guided waves. Transmission lines, plane wave propagation and reflection. Hollow waveguides and dielectric waveguides. Fiber optics, cavity and dielectric resonators. *Prerequisite:* EE 3330.

7332. Electromagnetics: Radiation and Antennas. Polarization, reflection, refraction and diffraction of EM waves. Dipole, loop and slot/reflector/antennas. Array analysis and synthesis. Self- and mutual impedance. Radiation resistance. *Prerequisite:* EE 3330.

7333. Antennas and Radiowave Propagation for Personal Communications. Three important aspects of telecommunications: fixed site antennas, radiowave propagation and small antennas proximate to the body. Includes electromagnetics fundamentals; general definitions of antenna characteristics; electromagnetic theorems for antenna applications; various antennas for cellular communications including loop, dipole and patch antennas; wave propagation characteristics as in earth-satellite communications, radio test sites, urban and suburban paths, and multipath propagation; and radio communication systems. *Prerequisite:* EE 3330.

7335. Quantum Electronics. Optical properties of solids: wave-length dependent dielectric constant, reflectivity, dispersion relations, quantum principles of absorption and emission, free-carrier absorption, electric dipole transitions, resonant processes and field quantization. *Prerequisite:* EE 3330.

7336. Introduction to Integrated Photonics. The issues of integrated photonics. Covers four major areas: 1) fundamental principles of electromagnetic theory, 2) waveguides, 3) simulation of waveguide modes and 4) photonic structures. The emphasis is greater on optical waveguides and numerical simulation techniques because advances in optical communications will be based on nanostructure waveguides coupled with new materials. Includes Maxwell's equations; slab, step index, rectangular and graded index waveguides; dispersion; attenuations; non-linear effects; numerical methods; and coupled mode theory. Mathematical packages such as MATLAB and/or Mathematica will be used extensively in this class. *Prerequisites:* EE 3311 and EE 3330.

7340. Biomedical Instrumentation. Application of engineering principles to solving problems encountered in medicine and biomedical research. Includes transducer principles, electrophysiology and cardiopulmonary measurement systems. *Prerequisites:* EE 2122 and EE 2322.

7345. Medical Signal Analysis. A look at the analysis of discrete-time medical signals and images. Includes the design of discrete-time filters, medical imaging and tomography, signal and image compression, and spectrum estimation. The course project explores the application of these techniques to actual medical data. *Prerequisite:* EE 3372.

7356 (CSE 7356). VLSI Design and Lab. Laboratory-oriented course for seniors and Master's-level graduate students. An overview of IC circuit design and fabrication process, basic design rule and layout techniques. Emphasis on digital design. Covers CMOS and NMOS technology. Each student must complete one or more design projects by the end of the first term. *Prerequisites:* EE 2381 and 3311.

7357. CAE Tools for Structured Digital Design. The use of CAE tools for the design and stimulation of complex digital systems. Verilog, a registered trademark of Cadence Design Systems, Inc., hardware description language, will be discussed and used for behavioral and structural hardware modeling. Emphasizes structured modeling and design. Design case studies include a pipelined processor, cache memory, UART and a floppy disk controller. *Prerequisite:* EE 2381 or permission of the instructor.

7360. Analog and Digital Control Systems. Feedback control of linear continuous and digital systems in the time domain and frequency domain. Includes plant representation, frequency response, stability, root locus, linear state variable feedback and design of compensators. *Prerequisite:* EE 3372.

7362 (ME 7302). Systems Analysis. State space representation of continuous and discrete-time systems, controllability, observability and minimal representations. Linear state variable feedback, observers and quadratic regulator theory. *Prerequisite:* EE 3372.

7370. Communication and Information Systems. An introduction to communication and modulation systems in discrete and continuous time, the information content of signals and the transitions of signals in the presence of noise. Amplitude, frequency, phase and pulse modulation. Time and frequency division multiplex. *Prerequisite:* EE 3360 or equivalent.

7371. Analog and Digital Filter Design. Approximation and analog design of Butterworth, Chebyshey and Bessel filters. Basic frequency transformations for designing low-pass, band-pass, band-reject and high-pass filters. Concept of IIR digital filters using impulse-invariant and bilinear transformations. Design of FIR digital filters using frequency sampling and window methods. Canonical realization of IIR and FIR digital filters. Wave digital filters. Introduction to two-dimensional filters. *Prerequisite:* EE 5372.

7372. Digital Signal Processing. An extended cover of processing of discrete-time signals. Reviews discrete-time signals and the analysis of systems in both the time and frequency domains. Covers multirate signal processing, digital filter structures, filter design and power spectral estimation. *Prerequisite:* EE 3372.

7373. DSP Programming Laboratory. Digital signal processors are programmable semiconductor devices used extensively in digital cellular phones, high-density disk drives and high-speed modems. A laboratory course that focuses on programming the Texas Instruments TMS320C55, a fixed-point processor. Emphasis on assembly language programming. A hands-on approach that focuses on the essentials of DSP programming while minimizing signal processing theory. Includes implementation of FIR and IIR filters, the FFT and a real-time spectrum analyzer. Suggested: Some basic knowledge of discrete-time signals and digital logic systems. *Prerequisite:* EE 3372.

7374. Digital Image Processing. An introduction to the basic concepts and techniques of digital image processing. Covers characterization and representation of images, image enhancement, image restoration, image analysis, image coding and reconstruction. *Prerequisite:* EE 7372.

7375. Random Processes in Engineering. An introduction to probability and stochastic processes as used in communication and control. Includes probability theory, random variables, expected values and moments, multivariate Gaussian distributions, stochastic processes, autocorrelation and power spectral densities, and an introduction to estimation and queuing theory. *Prerequisite:* EE 3360 or permission of the instructor.

7376. Introduction to Computer Networks. Basic topics in communication networks with an emphasis on layered protocols and their design. Includes OSI protocol reference model, data link protocols, local area networks, routing, congestion control, network management, security and transport layer protocols. Network technologies include telephony, cellular, Ethernet, IP TCP and ATM. Assignments may include lab exercises involving computer simulations. *Prerequisite:* None; knowledge of basic probability may be helpful, but is not necessary.

7377. Wireless Communication and Lab. Exposes students to a wide variety of real world experiences in wireless communications. Includes basic concepts of channel coding, modulation and power control, and uses specific examples from cellular and wireless LAN systems. Covers diversity and multiple access aspects of these systems. Lab experiments include: 1) study of signaling modes and transmission schemes in GSM and characterizing the performance, 2) understanding the basic anatomy of a voice call in GSM, 3) data throughput study in IEEE 802.11 based wireless LANs and 4) device discovery, topology management and data transfer in Bluetooth networks. *Prerequisite:* EE 3360 or equivalent.

7381. Digital Computer Design. Emphasizes design of digital systems and register transfer. Design conventions, addressing modes, interrupts, input-output, channel organization, high-speed arithmetic, hardwired and microprogrammed control. Central processor organization design and memory organization. Each student will complete one or more laboratory projects by the end of the course. *Prerequisite:* EE 2381.

7385. Microprocessors in Digital Design. Intended to help prepare the digital design engineer for use of microprocessors as programmable logic components in digital systems design. Topics include: fundamentals of both hardware and software engineering and their interrelationship with the microprocessor, capabilities and limitations of the Freescale 32 bit microprocessor family, use of hardware/software development systems, assembly language programming for Coldfire, and input-output interfacing and concepts involved in real-time applications. Also, features of similar processors will be covered. Each student will complete one or more laboratory projects by the end of the course. *Prerequisites:* EE 3181 and EE 3381.

7387 (CSE 7387). Digital Systems Design. Modern topics in digital systems design including the use of HDLs for circuit specification and automated synthesis tools for realization. Programmable logic devices are emphasized and used throughout the course. This course has heavy laboratory assignment content and a design project. *Prerequisite:* EE 2381 (grade of *C*- or better) or CSE 3381 (grade of *C*- or better).

7(0,1,2,3,6)96. Master's Thesis. Variable credit, but not more than six term credit hours in a single term and not more than four term credit hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours.

8(1–3)9(0–9). Special Topics. This special topics course must have a section number associated with a faculty member. The second digit corresponds to the number of term credit hour(s), which ranges from one to three term credit hours. The last digit ranges from zero to nine and represents courses with different topics.

8322. Semiconductor Lasers. A detailed understanding of the physics of quantum well semiconductor lasers. Uses computer-aided design tools (MODIG/WAVEGUIDE and GAIN) to design and model state-of-the art strained quantum well lasers currently used in telecommunications. Uses the Envelope Function Approach to derive E-k bands and band diagrams of strained quantum well photonic devices. Also includes the Fermi golden rule, electron-photon interactions, spontaneous and stimulated emission, optical gain as a function of energy (wavelength) and current density. Differential gain, small signal analysis, gain compression and the linewidth enhancement factor. Coupled-mode theory, distributed feedback lasers and modulators.

8328. Semiconductor Devices. Metal-semiconductor devices, PN junctions, bipolar transistors, junction field-effect transistor, insulated-gate field-effect transistors and power devices.

8331. Microwave Electronics. A study of microwave circuit design covering amplifiers, mixers and oscillators using s-parameters. Includes scattering parameters, transmission lines, impedance matching, network synthesis, stability, noise, narrowband and broadband amplifier design, low-noise amplifiers, multistage amplifiers, biasing considerations, microwave oscillators and microwave mixers. Relationships to CAE tools. *Prerequisite:* EE 3330, EE 7330 or EE 7332.

8332. Numerical Techniques in Electromagnetics. An introduction to various numerical methods in electromagnetics, with emphasis on practical applications. Includes the moment method, finite difference method and finite element method. *Prerequisites:* EE 7330 and proficiency in one computer language (e.g., FORTRAN) or permission of the instructor.

8333. Advanced Electromagnetic Theory. The advanced level of electromagnetic theory beyond EE 5330. Includes various electromagnetic theories and principles. Green's functions and perturbational and variational techniques. *Prerequisite:* EE 7330.

8355. Transistor Integrated Circuits. An introduction to CMOS, BJT and BiCMOS analog-integrated circuits. Includes development of detailed, physically based device models for SPICE simulation and application of these to components of operational amplifiers such as bias, differential, gain and output stages; frequency response and compensation; and feedback circuits. Emphasis on modern CMOS operational amplifier design with BiCMOS applications. As an extension of EE 7321, this course covers the topics in more depth and considers high-frequency aspects of analog circuits.

8356. Advanced Topics in VLSI Design. Advanced VLSI course for graduate students. Focuses on high performance and low-power design in deep sub-micron CMOS technologies. There will be a project associated with this course.

8357 (CSE 8357). Design of CAD/CAE Tools. Algorithm and software development techniques for design and implementation of CAD/CAE tools. Emphasizes development of tools for VLSI and digital systems design. Includes database development to support design environments and representation, characteristics and design of synthesis, static analysis and dynamic analysis tools. Also covers human interface issues and CAD/CAE output formats. *Prerequisite:* EE 5356 or experience with design using CAD/CAE tools and programming skills.

8361. Optimal Control of Deterministic and Stochastic Systems. Topics related to deterministic system control, including applications of the variational calculus using Hamiltonian methods, optimization with control variable constraints, maximum principle, linear quadratic problem, Ricatti equation and principle of optimality. Also, optimal stochastic control, including point estimation, state estimation, Kalman filter, linear quadratic Gaussian problem and separation principle. *Prerequisites:* EE 7360 and EE 7375.

8364. Statistical Pattern Recognition. Introduction to various parametric and nonparametric statistical approaches to automatic classification of a set of processes. Includes Bayes, Neyman-Pearson, Minimax, sequential and nearest-neighbor classifiers, estimation of classifier error, parameter estimation, density function estimation, linear discriminant functions, feature selection and evaluation, unsupervised recognition techniques and clustering analysis. *Prerequisite:* EE 7375 or equivalent.

8365. Adaptive Filters. A detailed treatment of the theory and application of adaptive filter processing. Includes linear prediction, stochastic gradient (LMS) adaptive transversal filters, recursive least-squares adaptive transversal filters, lattice filters and fast RLS algorithms. Also adaptive equalization, echo cancellation, system identification, beamforming, speech coding and spectral estimation. *Prerequisites:* EE 7372 and EE 7375 or permission of the instructor.

8366. Artificial Neural Networks. An introduction to Artificial Neural Networks and some applications. Includes Associative Memories, Hopfield model and extensions, optimization problems, simple perceptrons, multilayer networks, recurrent networks, application to supervised pattern recognition, unsupervised competitive learning, Kohonen networks and adaptive resonance theory. *Prerequisites:* Some background in multivariate calculus, probability and statistics; linear algebra.

8367 (ME 8367). Nonlinear Control. An introduction to methods of the control of nonlinear systems. Reviews phase plane analysis of nonlinear systems, Lyapunov theory, nonlinear stability and describing function analysis. Includes feedback linearization, sliding control and adaptive control. Special emphasis on the application of the developed concepts to the robust regulation of the response of nonlinear systems. *Prerequisite:* EE 7362.

8368. Signal Processing for Wireless Communications. Focuses on signal processing used in wireless communications. Emphasis on channel equalization, which can be considered a form of temporal signal processing, spatial array processing and space-time processing. Includes classical and blind channel equalization, Fourier, parametric and subspaced-based direction finding methods for smart antennas and space-time signal processing. *Prerequisite:* EE 7372.

8370. Analog and Digital Communications. Review of probability theory and stochastic processes. Characterization of communication signals and systems, optimum receivers, signal design for a communication through band-limited channels and applications in wireless communications.

8371. Information Theory. An investigation of the fundamental performance limits of communication systems. Developments and proofs of Shannon's three theorems, involving channel capacity, lossless source coding and rate distortion theory. Includes entropy, entropy rate, mutual information, discrete memoryless channels and sources, and the additive white Gaussian noise channel. *Prerequisites:* EE 7370 and EE 7375.

8372 (CSE 8352). Cryptography and Data Security. Cryptography is the study of mathematical systems for solving two kinds of security problems on public channels: privacy and authentication. Covers the theory and practice of both classical and modern cryptographic systems. The fundamental issues involved in the analysis and design of a modern cryptographic system will be identified or studied. *Prerequisite:* STAT/CSE 4340 or equivalent.

8373. Digital Speech Processing. A detailed treatment of theory and application of digital speech processing. Provides a fundamental knowledge of speech signals and speech processing techniques. Includes digital speech coding, speech synthesis, speech recognition and speech verification. *Prerequisite:* EE 7372.

8374. Fundamentals of Computer Vision. Introduction to the basic concepts and various techniques for computer analysis, interpretation and recognition of pictorial data. Includes binary image analysis, edge and curve detection, image segmentation, shape and texture representation and recognition, morphological methods and stereo vision. *Prerequisite:* Familiarity with basic concepts in signal processing and probability theory.

8375. Error Control Coding. The construction and decoding of block codes and convolutional codes. Bounds on code performance and performance tradeoffs. Introduction to trellis coded modulation and turbo codes. Typical applications of error control coding. *Prerequisite:* EE 8370 or permission of the instructor.

8376. Detection and Estimation Theory. Advanced topics in detection and estimation, including asymptotic detector and estimator performance, robust detection and nonparametric detection techniques. *Prerequisite:* EE 8370.

8377. Advanced Digital Communications. Equalization, digital communication through fading and multipath channels, spread spectrum, multi-user communications and wireless applications. *Prerequisite:* EE 8370 or permission of the instructor.

8378. Performance Modeling and Evaluation of Computer Networks. Probabilistic modeling and evaluation techniques to understanding the behavior of traffic, switching and network protocols. Includes basic queuing theory, traffic models, multiplexing, scheduling, switch models, routing and traffic control, in the context of protocols such as TCP/IP and ATM. *Prerequisites:* Probability, random processes and some knowledge of networks. EE 5376, EE 7376 and CSE 6544 are recommended.

8(0,1,2,3,6,9)96. Dissertation. Variable credit but no more than 15 term hours in a single term and no more than 10 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of dissertation hours. For example, 12 term hours of dissertation would require registration in EE 8396 and EE 8996.

Telecommunications Courses (EETS)

EETS courses are designed for the M.S. degree in telecommunications or to be taken as a part of the M.S.E.E. with the telecommunications specialization option.

7301 (CSE 7376). Introduction to Telecommunications. Overview of public and private telecommunications systems, traffic engineering, switching, transmission and signaling. Channel capacity, media characteristics, Fourier analysis and harmonics, modulation, electromagnetic wave propagation and antennas, modems and interfaces, and digital transmission systems. DSL technologies, digital microwave, satellites, fiber optics and SONET, and Integrated Services Digital Networks.

7302 (ENCE 7367). Telecommunications Management and Regulation. The managerial sequel to EETS 7301 Introduction to Telecommunications. A historical review of the most significant regulation and management issues affecting the telecommunications industry during the past 100 years. Also explores the regulatory environment in which it operates today through the study of current events articles and recent state and federal legislation. *Prerequisite:* EETS 7301 or experience in the telecommunications industry.

7303. Fiber Optic Telecommunications. An introductory course designed to familiarize students with practical concepts involved in optical fiber communications systems. Develops basic optical principles. Includes dielectric-slab waveguides, fiber waveguides and integrated optics devices. Covers the major components of a fiber communications link, including optical sources, detectors and fibers. Also the current state of the art and expected future directions in optical telecommunications, such as coarse and dense wavelength division multiplexing and dispersion compensation (electronic and optical methods).

7304. Internet Protocols. An introductory course on the protocol architecture of the Internet, following a bottom-up approach to the protocol layers. Provides an understanding of the internetworking concepts in preparation for advance networking courses. Includes 1) networking technologies such as local area networks, packet switching and ATM, 2) the Internet protocol and TCP/UDP in depth and 3) an overview of important application protocols such as HTTP, client/server computing, SMTP, FTP and SNMP. *Prerequisite:* EETS 7301 or equivalent.

7306. Wireless, Cellular and Personal Telecommunications. Comprehensive course in the fast developing field of wireless mobile/cellular and personal telecommunications. Mobile/cellular communications: frequency allocations, base station site selection, cellular structures, channel trunking, analog cellular signaling, handover, data over cellular, multipath fading, diversity reception, modulation techniques, speech coding, digital cellular design including GSM and TDMA, spectral efficiency considerations, spectral management and regulations, roaming, and current world systems and standards. Personal communications: basic concepts and terminology for PCS; PCS technology; design based on CSM, TDMA and CDMA; spectrum sharing with other services such as FSM; PCS standards; intelligent networks for PCS; global challenges for PCS; third-generation wireless; number portability and roaming; and satellites in wireless. *Prerequisites:* EETS 7301 and EETS 7320 or EE 5370 or permission of the instructor. Primarily for the telecommunications program but can also be very useful for EE students who plan to specialize in this field.

7315. Data Communications. Overview of Open Systems Interconnection Reference Model. Design criteria and issues for data communications systems, and protocols and standards relating to OSI Reference Model at layers 1–4, including the following: asynchronous transfer mode, serial interfaces, synchronization issues, link protocols, error detection, multiplexers, packet switching, virtual networks and services, local area networks, bridges, routers, hubs, narrowband and broadband ISDN, TCP/IP and optimization techniques.

7320. Digital Telecommunications Technology. Introduction and overview of advanced electronics technologies in telecommunications. The objective of this course is to give the student an understanding of the relevant technology to support proper decision making in the design, installation and operation of telecom systems. Stresses that telecom systems must provide technology supporting a useful service at an economically attractive price. *Prerequisite:* EETS 7315.

8305. Telecommunications Software Design. Comprehensive course to familiarize telecommunications professionals with the state-of-the-art software concepts and technology in modern telecommunications applications. Focuses on software process modeling, user interface design, CASE tool, reusability, quality assurance, reliability, distributed computing, real-time operating system and database and understanding of Real-Time Object-Oriented Modeling in analysis and design, and high-level programming language design concepts such as C++ as required in telecommunications software development. Emphasis on real-world applications, including Central Office or Private Branch Exchange switch, Computer Telephone Integration, LAN-to-WAN Node Processor, Advanced Intelligent Network, Cellular/Personal Communications Service, Asynchronous Transfer Mode, Integrated Services Digital Network and demonstration of ObjecTime, a Real-Time Object-Oriented Modeling software tool. *Prerequisites:* EETS 7301 or permission of the instructor, plus knowledge of one high-level programming language, preferably Pascal, C or C++.

8307. Telecommunications Network Management. Comprehensive course in the important issues in telecommunications network management. Overview of the underlying principles – operation, administration, maintenance and provisioning – which are often the most expensive and labor-intensive aspects of telecommunications. Includes different paradigms for network management such as the Internet Simple Network Management Protocol (SNMP, SNMPv2) and the Open System Interconnection Common Management information protocol. Covers the object-oriented modeling approach such as the ITU-T Telecommunications Management Network and Bellcore's Information Networking Architecture. Also, implementation issues of architectural concepts into network products and systems such as the translation from ISO Guidelines for the Definition of Managed Objects into C++. Network simulation, configuration, fault, security, accounting, performance management and the quality of service concepts. Drivers for network management and its traditional practice, as well as future needs. Case studies in Intelligent Network and Synchronous Optical Network. *Prerequisites:* EETS 8305 or permission of the instructor, plus knowledge of one high-level programming language, preferably Pascal, C or C++.

8311. Intelligent Networks (IN). A comprehensive course in providing broad knowledge in IN by exploring the theoretical network/call models of the ITU-T and ANSI and practical experiences of implementing IN technologies and services. Explains in detail important IN elements such as the Service Creation Environment, Service Management Systems, Service Control Point, Signal Transfer Point, Service Switching Point and Intelligent Peripheral. Includes implementation scenarios for IN elements starting with the ITU-T Service Independent Building Blocks to actual service deployment. Covers harmonization of IN with Telecommunications Management Network, the future of IN with migration to Telecommunication Information Networking Architecture and hurdles to IN, e.g., feature interaction, Local Number Portability example and IN/IP/CTI integration. Live demos of IN service creation and execution. *Prerequisite:* Permission of the instructor.

8313. Internet Telephony. A comprehensive introduction to the background, protocols, standards and issues related to Internet telephony. Describes the changing telecommunications environment that motivates the transition from today's telephone network to voice over IP and strategies being used by companies and individuals to implement VoIP. Covers as an umbrella protocol the Session Internet Protocol with its partner Session Description Protocol. Also, other protocols including H.323, RSVP, RTP, DNS, TRIP, ISUP and SS7. Issues including emergency services, security, mobility and quality of service. On-campus students and off-campus students with high-speed Internet access will have access to SIP lab equipment. *Prerequisites:* EETS 7301 and EETS 7315 or permission of the instructor.

8315. Advanced Topics in Wireless Communication. Focuses on third generation systems, wireless data and emerging wireless systems and technologies. Covers the IMT2000 requirements, proposals and evolution path for CDMA and TDMA technologies toward 3G. Detailed study of Radio Access network for the General Pack Radio Services, Enhanced Data for Global TDMA Evolution, WCDMA and CDMA2000 as well as core network evolution. Also covers second generation wireless data systems such as Cellular Digital Packet Data and Short Message Services. Mobile IP and Wireless Application Protocol. Other topics that may be covered include LMDS, WILL, indoor systems, cordless phones and WLAN. *Prerequisite:* EETS 7306 or permission of the instructor.

8316. Wireless Networks. A comprehensive introduction to various transport layer protocols especially focusing on wireless networks. Begins with a study of various traffic scenarios in different elements of a wireless network. Then, looks at various applications using 3G. Finally, discusses methods for performance monitoring and network testing. *Prerequisite:* EETS 7306.

8317. Switching and QoS Management in IP Networks. A comprehensive course on Internet protocol switching and quality of service management technology, protocols and applications. Part I concentrates on the fundamentals of IP and ATM switching architecture, including the Internet Engineering Task Force efforts on IP switching technology and the commercial deployment of multiprotocol label switching equipment and its evolution toward IETF MPLS architecture. In contrast to the current data-oriented best-effort IP network, the next-generation IP network will have to carry time-critical and QoS sensitive real-time traffic, such as voice and video. Thus, the mechanisms for guaranteeing QoS for service requirements are critical in an MPLS network. Part II addresses the mechanisms for end-to-end QoS management in an MPLS network, including MPLS traffic engineering, MPLS support for integrated and differentiated services, QoS routing algorithms and MPLS signaling support for RSVP-TE and CR-LDP. Bandwidth Broker and Service Level Agreement server. Policy-based architecture for QoS management methods will also be discussed. Part III focuses on the applications and network-evolution issues of MPLS technology, including MPLS-based VPN architecture and MPLS over DWDM networks and GMPLS.

8318. Wireless Internet. A comprehensive course in providing broad knowledge on Bluetooth and Wireless Application Protocol wireless standards, technologies, protocols and applications. Bluetooth is a wireless technology for small devices such as personal digital assistants, cell phones and computers to communicate seamlessly without cables or wires. The goal of WAP is to bring Internet content and advanced services to wireless handsets and other wireless terminals and to create a global wireless protocol specification to work across differing wireless network technologies. Wireless Markup Language serves as the markup language for browser display on wireless devices. This unique class works to baseline the current Bluetooth and WAP/WML standard effort and to define the parameters of the technical wireless communications environment. The course explains the contributing technologies of the Bluetooth and WAP/WML in detail, outlining new directions and products already emerging and surveying the imminent technologies that create a brand of new telecommunications environment. Students will acquire hand-on experience in writing WAP/WML software applications as a term project.

8319. Optical DWDM Networks. Provides a basic understanding of the underlying optical networking technologies from concept and design to deployment. Optical networks, especially the dense wavelength division multiplexing, are not just for long-haul systems anymore. Using DWDM adds an important new dimension to existing fiber networks in metropolitan and local access network environments. This course begins with a look at the bandwidth drivers that will determine the coming requirements for this novel technology and considers the business case for its deployment. Reviews fiber-optic technology with an emphasis on the characteristics of particular fiber types used to support DWDM technology, as well as the workings of a DWDM system. Also discusses key DWDM technologies, such as optical filters, optical amplifiers, optical add/drop multiplexing systems, optical cross connect switches and other optical communication devices, keeping in mind the impairments that can limit DWDM transmission distances and speeds. Finally, presents current DWDM network configurations and architectures with a focus on the real-world applications of this promising new technology. Emphasizes DWDM system design issues, DWDM ring and mesh network topologies, fault avoidance, provisioning, performance monitoring and issues of current research. *Prerequisite:* EETS 7301. *Recommended:* EETS 7303.

8321. Telecommunications Network Security. A graduate-level survey of the technologies underlying network security. First, covers the principles of private and public key cryptography. Describes a number of examples of encryption algorithms, including DES and AES. Includes the use of encryption with hash functions for digital signatures and certificates. Second, covers perimeter security including firewalls, intrusion detection systems, viruses and worms. Finally, covers a number of secure protocols including secure e-mail, secure

HTTP, IPSec and virtual private networks. Does not cover topics that are part of general security but peripheral to network security, e.g., physical tamper resistance, security policies, digital rights management and biometrics. *Prerequisite:* EETS 7315.

8322. Data Compression for Multi-Media Applications. An introduction to techniques for efficient compression and coding of audio and video signals for multimedia applications. Includes speech and vision models, sampling and quantization of one- and two-dimensional signals, coding techniques for audio and video signals, and existing and evolving standards for audio and video coding. *Prerequisite:* EETS 7315 or permission of the instructor.

ENGINEERING MANAGEMENT, INFORMATION AND SYSTEMS

Associate Professor Richard S. Barr, **Chair**

Professors: Jeffery L. Kennington, Stephen A. Szygenda, Margaret H. Dunham (Computer Science and Engineering), Marion Sobol (Business). **Associate Professors:** Richard V. Helgason, Eli V. Olinick, Jerrell R. Stracener, Jeff Tian. **Assistant Professor:** Junfang Yu. **Senior Lecturer:** Thomas Siems. **Lecturers:** Leslie-Ann Asmus, Mary Alys Lillard, Gretchen Miller. **Adjunct Faculty:** Karl Arunski, Chris Askew, John D. Baschab, Charles Beall, Robert L. Bell, William David Bell, Ann E. Broihier, George W. Chollar, Eric Cluff, Kevin D. Cluff, David Cochran, Howard Cowin, Gunter Daley, Chris Davis, Peter DeLisle, Dennis Delzer, Matthew L. Durchholz, Dennis Frailey, Ganesh L. Harpavat, James Hinderer, Michael Hopper, Donna Hutcheson, Gerard Ibarra, Dario Nappa, Robert S. Oshana, David Peters, Oscar K. Pickels, Jon C. Piot, James Rodenkirch, Christopher Rynas, Mark E. Sampson, Steven P. Sanazaro, Nand M. Singh, Steve Skinner, Gheorghe Spiride, William Swanson, John W. Via, III, John Yarrow, Hossam Zaki. ***Emeritus* Professor:** U. Narayan Bhat (Statistics).

Leaders need more than technical knowledge in today's complex working world. EMIS programs develop leadership, engineering and management skills for success in technology-based organizations. The same systems-oriented, mathematical-model-based approach to design – which has been the cornerstone of engineering for decades – has powerful application within technology-based organizations.

The EMIS department offers four programs and seven degrees to prepare graduates for leadership in their chosen career:

- **Engineering Management** develops expertise in applying engineering principles to managing technology-based projects and people in technical roles.
- **Operations Research** applies advanced analytical methods to help make better decisions. By using techniques such as mathematical modeling to analyze complex situations, operations research gives managers the power to make more effective decisions and build more productive systems.
- **Systems Engineering** develops expertise for the creation and management of a complex system by viewing it as a whole, over its life cycle, using systems-engineering principles, methods and practices.
- **Information Engineering and Management** provides the graduate with the tools to effectively engineer and manage the information flow of an organization by developing management skills that take advantage of software, networking, hardware and technology.

The unifying theme of these efforts is the application of engineering principles and techniques to enhance organizational performance. Faculty specializations include optimization, telecommunications network design and management, supply-chain systems, systems engineering, logistics engineering, quality control, reliability engineering, information engineering, benchmarking, operations planning and management, network optimization and mathematical programming. Whether the graduate will be in a technology firm, the military or a not-for-profit organization, he or she will develop the essential technical and leadership skills in the Engineering Management, Information and Systems Department.

Graduate Degrees

The EMIS department offers the following graduate degrees:

Master of Science (Major in Operations Research)
Master of Science (Major in Systems Engineering)
Master of Science in Engineering Management
Master of Science in Information Engineering and Management
Doctor of Philosophy (Major in Operations Research)
Doctor of Philosophy (Major in Systems Engineering)
Doctor of Engineering (Major in Engineering Management)

Courses for these programs are offered both on-campus and off-campus via several remote-delivery systems. Master's degrees may be completed through distance education via on-line video, as may most of the coursework for doctoral degrees. See the Off-Campus Distance Education section for more information on distance education delivery systems.

The Department of Engineering Management, Information and Systems also offers:

- Executive/weekend versions of selected Master's degrees in the Dallas-Fort Worth area.
- A certificate series in systems engineering and information engineering with career-building instruction for nondegree-seeking students.
- Fast multiple Master's options, which can reduce coursework requirements when pursuing multiple graduate degrees.

These offerings are described in this section. For the most up-to-date information on programs and activities, see the departmental website at lyle.smu.edu/emis.

Master of Science (Major in Operations Research)

Director: Richard S. Barr

Faculty: Leslie-Ann Asmus, Richard Helgason, Jeffery Kennington, Eli Olinick, Thomas Siems, Jerrell Stracener, Junfang Yu. **Adjunct Faculty:** Gheorghe Spiride, Hossam Zaki. ***Emeritus* Faculty:** U. Narayan Bhat (Statistics).

Operations research is the study of technical and analytical tools for management decision making. The growth of the field is closely linked to developments in computing capabilities. The analyst must have a solid working knowledge of computers to manage and process enormous amounts of information vital to the daily activities of a modern complex organization. The program is designed to prepare graduates for industrial and governmental opportunities in management consulting, transportation, telecommunications, aerospace, defense, manufacturing, logistics and the service industries.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy the following additional requirements:

1. Bachelor of Science in engineering, mathematics, computer science, economics or a related technical field.
2. Previous coursework that includes satisfactory completion of at least six credit hours of calculus, three hours of linear algebra and three hours of computer programming in a high-level language. (Generally, a Bachelor of Business Administration does not provide sufficient background.)

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy the following additional requirements:

1. Satisfactory completion of one of the following probability and statistics courses:

   EMIS 7370 (STAT 5430) Probability and Statistics for Scientists and Engineers *or*
   EMIS 7377 (STAT 5377) Statistical Design and Analysis of Experiments

   and the following three core courses:

   EMIS 7362 Production Systems Engineering
   EMIS 8360 Operations Research Models
   EMIS 8371 Linear Programming

2. Satisfactory completion of three of the following in-depth courses:

   EMIS 7361 Computer Simulation Techniques
   EMIS 8361 Engineering Economics and Decision Analysis
   EMIS 8372 (STAT 6372) Queuing Theory
   EMIS 8373 Integer Programming
   EMIS 8374 Network Flows
   EMIS 8378 Optimization Models for Decision Support
   EMIS 8380 Mathematics for Optimization
   EMIS 8381 Nonlinear Programming

3. Satisfactory completion of nine term credit hours from a second area. These concentration courses must be from the same area and must be approved by the adviser. Acceptable areas are optimization, systems engineering, engineering management, information engineering, computer science, mathematics, statistics, telecommunications or another engineering discipline. Sample concentration areas (with suggested courses) are:

   Optimization
   EMIS 8373 Integer Programming
   EMIS 8374 Network Flows
   EMIS 8378 Optimization Models for Decision Support
   EMIS 8380 Mathematics for Optimization
   EMIS 8381 Nonlinear Programming

   Systems Engineering
   EMIS 7300 Systems Analysis Methods
   EMIS 7301 Systems Engineering Process
   EMIS 7303 Integrated Risk Management
   EMIS 7305 Systems Reliability, Supportability and Availability Analysis
   EMIS 7307 Systems Integration and Test

   Engineering Management
   EMIS 7360 Management of Information Technologies
   EMIS 8361 Engineering Economics and Decision Analysis
   EMIS 8362 Engineering Accounting
   EMIS 8363 Engineering Finance
   EMIS 8364 Engineering Management

   Information Engineering
   EMIS 7351 Enterprise Fundamentals
   EMIS 7352 Information System Architecture
   EMIS 7353 Information System Design Strategies
   EMIS 7357 Decision Support Systems
   EMIS 7360 Management of Information Technologies

Master of Science
(Major in Systems Engineering)

Director: Jerrell Stracener

Faculty: Leslie-Ann Asmus, Richard Barr, Richard Helgason, Jeffery Kennington, Eli Olinick, Jeff Tian, Junfang Yu. **Adjunct Faculty:** Karl Arunski, Chris Askew, Robert L. Bell, William Bell, Ann Broihier, George William Chollar, Eric Cluff, Kevin D. Cluff, David Cochran, Howard Cowin, Gunter Daley, Matthew Durchholz, James Hinderer, Michael Hopper, Gerard Ibarra, Dario Nappa, Robert Oshana, Jim Rodenkirch, Chris Rynas, Mark E. Sampson, Steve Skinner. ***Emeritus* Faculty:** U. Narayan Bhat (Statistics).

The goal of systems engineering is the development and management of systems (products and services) that satisfy customer requirements considering engineering, technology, environmental, management, risk and economic factors by viewing the system as a whole during its life cycle. Systems engineering is also the practice of "good engineering." Through systems engineering and related courses, the student gains a foundation in systems engineering plus exposure to a variety of topics such as reliability, quality, logistics/supply networks, operations research, engineering management, software engineering, telecommunications and environmental engineering. "Systems thinking" skills are developed, and these skills foster more effective practice for the engineer or engineering manager within the business enterprise. The systems engineering program's objective is to make the student a better engineer and manager by imparting an enhanced understanding of the impact of engineering decisions.

The program has been developed in response to the growing need by industry and government for engineers who are not only specialists in a particular area, but who also have a systems perspective in order to more effectively practice engineering and manage within the business enterprise. The program offers flexibility for: 1) systems engineers who are entering the field, updating skills or acquiring new skills, 2) engineers who need to acquire a broadening of their technical and management education from a systems perspective, 3) engineers with upper-level management aspirations and 4) engineering students seeking to increase their market value by acquiring knowledge and skills necessary for the engineering of products and services from a systems perspective.

The systems engineering program is designed to build on engineering/technical education and experience while developing problem definition and problem solving skills.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy the following additional requirements:

1. Bachelor of Science in engineering, mathematics or one of the quantitative sciences. (A Bachelor of Science in an appropriate engineering discipline is required for the systems engineering and design track.)
2. A minimum of two years of college-level mathematics, including at least one year of calculus.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy the following additional requirements:

1. Satisfactory completion of the core curriculum encompassing five courses:

   EMIS 7300 Systems Analysis Methods
   EMIS 7301 Systems Engineering Process
   EMIS 7303 Integrated Risk Management
   EMIS 7305 Systems Reliability, Supportability and Availability Analysis
   EMIS 7307 Systems Integration and Test

2. Satisfactory completion of one of the following tracks:

   Systems Engineering Technology Track
   Satisfactory completion of the following five courses:

   EMIS 7310 Systems Engineering Design
   EMIS 7312 Software Systems Engineering
   EMIS 7320 Systems Engineering Leadership
   EMIS 7330 Systems Reliability Engineering
   EMIS 7340 Logistics Systems Engineering

   Systems Engineering and Design Track
   Satisfactory completion of any five of the following courses:

   CSE 7365 (MATH 5315) Introduction to Numerical Analysis
   CSE 7376 Introduction to Telecommunications
   EE 7360 Analog and Digital Control Systems
   EE 7362 (ME 7302) Systems Analysis
   EE 7370 Communication and Information Systems
   EE 7374 Digital Image Processing
   ME 7331 Advanced Thermodynamics
   ME 7357 Optimized Mechanical Design
   ME 7358 Design of Electronic Packaging
   ME 8361 (EE 8361) Multivariable Control System Design

   Logistics and Supply-Chain Management Track
   Satisfactory completion of the following three courses:

   EMIS 7330 Systems Reliability Engineering
   EMIS 7340 Logistics Systems Engineering
   EMIS 7362 Production Systems Engineering

   Plus any two of the following courses:

   EMIS 7364 (STAT 5344) Statistical Quality Control
   EMIS 7369 Reliability Engineering
   EMIS 8360 Operations Research Models
   EMIS 8361 Engineering Economics and Decision Analysis
   EMIS 8378 Optimization Models for Decision Support

   Systems Engineering Application Track
   Satisfactory completion of five electives, with the approval of the student's academic adviser, in one of the following concentrations: (The concentration must be in a different field from the undergraduate major.)

   Computer Engineering
   Computer Science
   Electrical Engineering
   Engineering Management
   Environmental Engineering
   Information Engineering and Management
   Manufacturing Engineering
   Mechanical Engineering
   Operations Research
   Software Engineering
   Systems Engineering
   Telecommunications

Master of Science in Engineering Management

Director: Eli Olinick

Faculty: Leslie-Ann Asmus, Richard Barr, Richard Helgason, Jeffery Kennington, Mary Alys Lillard, Thomas Siems, Jerrell Stracener, Stephen Szygenda, Junfang Yu. **Adjunct Faculty:** John Baschab, Charles Beall, Peter DeLisle, Ganesh Harpavat, David Peters, Oscar K. Pickels, Jon C. Piot, Steven P. Sanazaro, Gheorghe Spiride, John W. Via, III, Hossam Zaki.

The Master of Science in engineering management was developed for individuals who have an undergraduate technical degree and are or will be rising through management or starting their own company. The engineering management degree is designed to impart essential knowledge for today and tomorrow's technology-driven business.

The MSEM program develops expertise in the traditional graduate business areas – finance and accounting – along with pace-setting, innovative expertise in information engineering, global perspectives, leadership and entrepreneurship. This well-rounded approach prepares individuals for success in the new world of techno-business with its challenges and opportunities.

A special feature of the engineering management program is its interaction with allied areas such as operations research, mathematics, science, engineering, computer science and statistics. Excellent faculty members from these areas participate in the department's activities, and students take courses from several areas depending upon their interests.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy the following additional requirement:

Bachelor of Science in engineering or another technical discipline.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy the following additional requirements:

1. Satisfactory completion of the following eight core courses:

   EMIS 8360 Operations Research Models
   EMIS 8361 Engineering Economics and Decision Analysis
   EMIS 8362 Engineering Accounting
   EMIS 8363 Engineering Finance
   EMIS 8364 Engineering Management
   EMIS 7301 Systems Engineering Process
   EMIS 7362 Production Systems Engineering
   EMIS 7370 (STAT 5430) Probability and Statistics for Scientists and Engineers

2. Satisfactory completion of two elective courses, approved by the adviser, in EMIS, computer science, engineering, mathematics or statistics.

Master of Science in Information Engineering and Management

Director: Richard S. Barr

Faculty: Leslie-Ann Asmus, Margaret H. Dunham, Richard Helgason, Jeffery Kennington, Mary Alys Lillard, Eli Olinick, Thomas Siems, Jerrell Stracener, Stephen Szygenda, Jeff Tian, Junfang Yu. **Adjunct Faculty:** John Baschab, Chris Davis, Dennis Frailey, Donna Hutcheson, Robert Oshana, Jon C. Piot, Steven P. Sanazaro, Gheorghe Spiride, John Yarrow.

Information engineering is the blending of engineering principles and best business practices to create and manage high-quality, effective and possibly strategic information infrastructures for an organization. The Master of Science in information engineering and management curriculum, designed in consultation with industry, covers topics in computer and telecommunications hardware and software, systems engineering, operations research, information technology strategy, global considerations and engineering management. It develops students' technical and managerial expertise in information technology and its design and application.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy the following additional requirement:

Bachelor's degree in engineering or another technical discipline. (The technical requirement may be waived with sufficient relevant work experience.)

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy the following additional requirements:

- Satisfactory completion of seven required core courses (21 term credit hours).
- Satisfactory completion of three electives (nine term credit hours).

Curriculum

The MSIEM course requirements are structured in four pedagogical groups, and students are encouraged to schedule their degree, by group, in the following order.

1. Foundational courses on enterprise and information systems fundamentals (nine term credit hours):

   EMIS 7351 Enterprise Fundamentals
   EMIS 7352 Information System Architecture
   EMIS 7353 Information System Design Strategies

2. Foundational courses on concepts to the construction of information systems and the management of operations (six term credit hours):

   EMIS 7360 Management of Information Technologies
   EMIS 7362 Production Systems Engineering

3. In-dept courses, advanced information engineering for strategic systems and managerial decision support (six term credit hours):

   EMIS 8356 Information Engineering and Global Perspectives
   EMIS 7357 Decision-Support Systems

4. Focus courses, for broadening or specialization to specific interests, applications or industries. A nine term credit hour elective set, approved by the adviser, which can include:

   EMIS 8358 Technical Entrepreneurship
   EMIS 7359 Information Engineering Seminar
   Other EMIS, computer science or engineering courses

IT Governance and Controls Track

In addition to the seven courses required for the MSIEM (EMIS 7351, 7352, 7353, 7357, 7360, 7362 and 8356), the following electives form an information technology governance and controls track within the MSIEM:

EMIS 7312 Software Systems Engineering
EMIS 7380 Managing Information Technology Controls
EMIS 7382 Information Technology Security and Risk Management

This degree track aligns the MSIEM with the industry-standard Information Systems Audit and Control Association International Model Curriculum and is only the fourth such degree offered in the United States. It prepares students for a career as an information system auditor or manager. The worldwide shortage of certified information system auditors and certified information security managers is critical. In North Texas alone, more than 1,500 openings for information technology risk managers or information technology auditors wait to be filled. Prospective IT auditors and IT risk management analysts who obtain the necessary training and certifications can reasonably expect to find immediate, stable, high-income employment opportunities.

Multiple Master's Degrees

SMU's Lyle School of Engineering permits its graduate students to take advantage of degree-requirement overlaps to acquire a second Master's degree by taking as few as six courses (18 term credit hours). This option is available for prospective and current graduate students, as well as alumni who have already received a M.S. from SMU.

The following guidelines must be followed by students wishing to receive two M.S. degrees:

1. The student must apply to and be admitted to both programs.
2. All requirements of both degrees must be met.
3. For the new (or second) Master's degree, a minimum of 18 term credit hours of graduate coursework must be taken, and it must be coursework that will not or has not been applied toward another SMU Lyle graduate degree.
4. For students who are currently enrolled in an SMU Lyle graduate program and who are seeking a new Master's degree, the degree will not be awarded until a minimum of 30 term credit hours of graduate coursework has been completed at SMU.

With careful planning, a student can develop an advanced education strategy leading to multiple degrees, including combinations with an M.S. in Engineering Management; M.S. in Information, Engineering and Management; M.S. with a major systems engineering; or M.S. with a major in operations research. Students apply and file degree plans for both degrees, and then complete the coursework. For examples of programs of study for obtaining two Master's degrees from the EMIS department, see the EMIS department website at lyle.smu.edu/emis.

Administrative Process

Students pursuing dual degrees must be admitted into each degree program separately. A separate application form and statement of purpose must be submitted for each, as follows:

- To apply for both degrees simultaneously, the student must include a note indicating that he or she is "applying for a second Master's," and a single application fee and set of transcripts will be required.

- If the student is already enrolled in one program, he or she must submit an application form and statement of purpose for the second degree, along with a note indicating that he or she is *applying* for (not a requesting a *transfer* to) a "second Master's program."

EMIS Executive Master's Programs

The Lyle School of Engineering's executive Master's degrees are two-year programs developed for rising and prospective technical managers who have technical undergraduate degrees and are moving up to higher management positions or starting their own company. It is a cohort weekend program that is restricted to a highly motivated group of area professionals and designed to impart essential knowledge for today's and tomorrow's technology-driven organizations.

The fast-track engineering management program develops expertise in applying engineering principles to managing technology-based projects and people in technical roles. This well-rounded approach prepares individuals for success in the new world of the technology-driven enterprise with its challenges and opportunities.

The systems engineering program develops expertise for the creation and management of complex systems (products and services) that satisfy customer requirements in considering engineering, technology, environmental, management, risk and economic factors by viewing the system as a whole during its life cycle, using systems-engineering principles, methods and practices.

The information engineering and management program provides the graduate with the tools to effectively engineer and manage the information flow within an organization. The curriculum is comprised of 10 courses, ranging from software, networking and hardware courses to courses in information-handling, management and system-level considerations.

As a tool for recruitment and retention, each of these degrees can be an ideal reward or incentive device to help companies attract and keep top talent. Best of all, the program is extremely cost-efficient, priced below other comparable programs. For more information on all of the EMIS executive Master's programs, see the department website at lyle.smu.edu/emis.

Doctor of Philosophy (Major in Operations Research)

Admission Requirements

1. Master's degree in engineering, mathematics, computer science, economics or a related technical field from a U.S. college or university accredited by a regional accrediting association or completion of an international degree that is equivalent to a U.S. Master's degree from a college or university of recognized standing.
2. Excellent academic performance in all completed coursework, with a minimum GPA of 3.0 on a 4.0 scale.
3. Previous coursework that includes satisfactory completion of at least nine credit hours of calculus, three hours of linear algebra and three hours of computer programming in a high-level language. (Typically, a Bachelor of Business Administration does not provide sufficient background.)
4. Submission of a complete application, including a statement of purpose, official transcripts for all previous undergraduate and graduate studies and payment of appropriate application fee.
5. Official GRE graduate school entry exam test results with a minimum 80th-percentile quantitative score.
6. Three letters of recommendation from individuals who can judge the applicant's potential success as a doctoral student.

7. Graduates from foreign countries are required to submit a notarized financial certification form. All international students whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English language proficiency score before being considered for admission as follows:
   - 550 – paper-based examination.
   - 213 – computer-based examination.
   - 59 – Internet-based examination.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the Doctor of Philosophy degree, candidates are required to satisfy the following:

1. A minimum of 54 term credit hours beyond the baccalaureate degree, plus 24 term credit hours of dissertation credit. Required courses are:

   MATH 5316 Numerical Linear Algebra
   EMIS 7361 Computer Simulation Techniques
   EMIS 7362 Production Systems Engineering
   EMIS 7370 (STAT 5340) Probability and Statistics for Scientists and Engineers
   EMIS 7377 (STAT 5377) Design and Analysis of Experiments
   EMIS 8360 Operations Research Models
   EMIS 8361 Engineering Economics and Decision Analysis
   EMIS 8372 (STAT 6372) Queuing Theory
   EMIS 8371 Linear Programming
   EMIS 8373 Integer Programming
   EMIS 8374 Network Flows
   EMIS 8378 Optimization Models for Decision Support
   EMIS 8380 Mathematics for Optimization
2. The 54 term credit hours also must include a 12 term credit hour minor. Acceptable minors include systems engineering, engineering management, information engineering, computer science, mathematics, statistics, economics, telecommunications or another engineering area. The courses for the minor must be different from the required courses, except for MATH 5316, which can be part of a minor in mathematics.
3. Satisfactory completion of the preliminary counseling examination, an oral exam covering operations research fundamentals. Skills tested include those developed in these courses: EMIS 7362, 7370, 8360 and 8361. This exam should be taken after the student has completed 18 term credit hours.
4. Satisfactory completion of the doctoral qualifying examination. This exam should be taken after the majority of the coursework has been completed.
5. Satisfactory completion and defense of the doctoral dissertation.

Sample Minors

Systems Engineering

EMIS 7301 Systems Engineering Process
EMIS 7303 Integrated Risk Management
EMIS 7305 Systems Reliability, Supportability and Availability Analysis
EMIS 7307 System Integration and Test

Engineering Management

EMIS 7360 Management of Information Technologies
EMIS 8362 Engineering Accounting
EMIS 8363 Engineering Finance
EMIS 8364 Engineering Management

Information Engineering

EMIS 7351 Enterprise Fundamentals
EMIS 7352 Information System Architecture
EMIS 7353 Information System Design Strategies
EMIS 7360 Management of Information Technologies

Five Steps to the Ph.D. in Operations Research

In addition to these five steps, process details and other requirements for the Doctor of Philosophy degree may be found elsewhere in the SMU Lyle School of Engineering Graduate Catalog.

1. **Basic Coursework:** Upon entry into the Ph.D. program, a student is assigned an academic adviser. The adviser will examine the student's prior background and current state of knowledge and then recommend courses to be taken in preparation for Step 2.
2. **Preliminary Counseling Exam and Program of Study:** To be eligible for advanced study, a student must demonstrate competence in operations research fundamentals by passing the preliminary counseling examination. This exam is oral and is administered by three faculty members. Particular emphasis will be given to the material covered in the following courses: EMIS 7362, 7370, 8360 and 8361.
3. **Appointment of Supervisory Committee and Advanced Coursework:** Upon completion of the preliminary counseling exam, the student develops a proposed program of study that meets the degree requirements in Section II and includes the planned advanced coursework. Based upon the proposed program of study, a supervisory committee is formed. The supervisory committee makes any needed adjustments to the program of study. Changes in the program of study are subject to approval by the supervisory committee. Step 3 requires completion of the forms Recommendation and Certification of Appointment of Supervisory Committee and Doctoral Degree Plan. (All forms are available for downloading at lyle.smu.edu/emis.)
4. **Qualifying Examination:** At or near the completion of the coursework, the supervisory committee conducts the qualifying examination. This exam ordinarily involves a series of take-home exams, but the format is left to the discretion of the supervisory committee. The qualifying examination is concluded by an oral exam at which time the student is expected to present a proposal for the dissertation. A written proposal must be given to the supervisory committee prior to the oral exam. Upon passing this exam, the student is admitted to doctoral candidacy. Step 4 requires completion of the form Admission to Candidacy.
5. **Dissertation Defense:** The most distinguishing characteristic of a program leading to the Ph.D. degree is the requirement that the candidate write a dissertation embodying the results of a significant and original investigation. The dissertation must make a significant contribution to the operations research discipline, and it is expected to be a mature and competent piece of writing. The defense, which is conducted orally, must enable the supervisory committee to satisfy itself that the dissertation is an original piece of research work, that it has been carried out in keeping with the highest standards of investigation and reporting and that it makes a contribution to knowledge that is of value to the scientific community. Satisfactory performance on this defense constitutes the last academic requirement to be met for the Ph.D. degree. Step 5 requires completion of the form Report on Thesis or Dissertation and/or Final Examination.

Doctor of Philosophy (Major in Systems Engineering)

Admission Requirements

Applicants must satisfy these requirements:

1. Master's degree in systems engineering or a related field including aerospace engineering, computer science, electrical engineering, engineering management, environmental engineering, civil engineering, industrial engineering, mechanical engineering, mathematics, operations research, statistics or physics from a U.S. college or university accredited by a regional accrediting association or completion of an international degree that is equivalent to a U.S. Master's degree from a college or university of recognized standing.
2. Excellent academic performance in all completed coursework, with a minimum GPA of 3.4 on a 4.0 scale.
3. A completed application, including a statement of research intent, official transcripts for all previous undergraduate and graduate studies and payment of the application fee.
4. Official GRE graduate school entry exam test results with a minimum 80th-percentile quantitative score.
5. A minimum of two years of college-level mathematics, including at least one year of calculus.
6. A minimum of three years of engineering experience in industry and/or government.
7. Three letters of recommendation from individuals who can judge the applicant's potential success as a doctoral student.
8. Graduates from foreign countries are required to submit a notarized financial certification form. All international students whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English language proficiency score before being considered for admission as follows:
   - 550 – paper-based examination.
   - 213 – computer-based examination.
   - 59 – Internet-based examination.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the Doctor of Philosophy degree, candidates are required to satisfy the following:

Minimum Credit Requirements

1. Thirty term credit hours of core systems engineering courses. These hours must come from required graduate-level courses in systems, as specified in this section.
2. Fifteen term credit hours in an approved major that is related to a specific systems engineering focus area and consistent with anticipated doctoral research. No more than six credit hours can be independent study.
3. Nine term credit hours in an approved minor supporting the chosen research area. These hours can come from graduate-level courses in EMIS or other departments. The minor requirement may also be satisfied by transfer credit subject to SMU's Transfer of Credit Policy.
4. Twenty-four term credit hours for the dissertation. These hours must be taken in residence. The student enrolls for these hours in the course of writing the dissertation.

In addition, at least 18 term credit hours of the 54 term credit hour coursework minimum must be at the 8000 level. There must be a minimum of 24 term-credit hours of graduate coursework and a minimum of 24 term credit hours of dissertation work, none of which have been nor can be applied to any other degree.

Core Courses in Systems Engineering

The 10 required courses are:

EMIS 7301 Systems Engineering Process
EMIS 7303 Integrated Risk Management
EMIS 7305 Systems Reliability, Supportability and Availability Analysis
EMIS 7307 Systems Integration and Test
EMIS 7312 Software Systems Engineering
EMIS 7315 Systems Architecture Development
EMIS 7320 Systems Engineering Leadership
EMIS 7370 Probability and Statistics for Scientists and Engineers
EMIS 7377 Design and Analysis of Experiments
EMIS 8360 Operations Research Models

Systems Engineering Focus Areas

Systems Design and Development

EMIS 7310 Systems Engineering Design
EMIS 7330 Systems Reliability Engineering
EMIS 7335 Human-Systems Integration
EMIS 7347 Critical Infrastructure Protection/Security Systems Engineering
EMIS 8305 Systems Life Cost and Affordability Analysis
EMIS 8307 Systems Test and Evaluation
EMIS 7369 Reliability Engineering
EMIS 8310 Collective Systems Design
EMIS 8315 Innovation Systems Design
EMIS 8340 Systems Engineering Software Tools
EMIS 8342 Six Sigma Systems Engineering
CSE 7316 Software Requirements
CSE 7319 Software Architecture and Design
CSE 7347 XML and the Enterprise
CSE 8314 Software Metrics and Quality Engineering
CSE 8317 Software Reliability and Safety
CSE 8340 Advanced Topics in Software Engineering
ME 7350 Design for Manufacturability and Concurrent Engineering

Leadership and Management

EMIS 7318 Systems Engineering Planning and Management
EMIS 7365 Program and Project Management
EMIS 8364 Engineering Management
EMIS 8368 Enterprise Leadership
CSE 7315 Software Project Planning and Management
ME 7303 Organizational Leadership
ME 7368 Project and Risk Management
ME 7369 Innovation Management

Logistics and Supply Systems

EMIS 7340 Logistics Systems Engineering
EMIS 7362 Production Systems Engineering
EMIS 8361 Economic Decision Analysis
EMIS 8348 Supply Chain Systems Engineering

ENCE 7371 Facility Financial and Asset Management
ENCE 8379 Analysis of Transportation Systems

Systems Analysis and Optimization
EMIS 7361 Computer Simulation Techniques
EMIS 7362 Production Systems Engineering
EMIS 8361 Economic Decision Analysis
EMIS 8371 Linear Programming
EMIS 8372 Queuing Theory
EMIS 8374 Network Flows
EMIS 8373 Integer Programming
EMIS 8378 Optimization Models for Decision Support
EMIS 8380 Mathematics for Optimization

Five Steps to the Ph.D. in Systems Engineering

In addition to these five steps, process details and other requirements for the Doctor of Philosophy degree may be found elsewhere in the SMU Lyle School of Engineering Graduate Catalog.

1. **Basic Coursework:** Upon entry into the Ph.D. program, a student is assigned an academic adviser. The adviser will examine the student's prior background and current state of knowledge and then recommend courses to be taken in preparation for Step 2.
2. **Preliminary Counseling Exam and Program of Study:** To be eligible for advanced study, a student must demonstrate competence in systems engineering fundamentals by passing the preliminary counseling examination. This exam is oral and is administered by three faculty members. Particular emphasis will be given to the material covered in the following courses: EMIS 7301, 7303, 7305 and 7307.
3. **Appointment of Supervisory Committee and Advanced Coursework:** Upon completion of the preliminary counseling exam, the student develops a proposed program of study that meets the degree requirements in Section II and includes the planned advanced coursework. Based upon the proposed program of study, a supervisory committee is formed. The supervisory committee makes any needed adjustments to the program of study. Changes in the program of study are subject to approval by the supervisory committee. Step 3 requires completion of the forms Recommendation and Certification of Appointment of Supervisory Committee and Doctoral Degree Plan. (All forms are available for downloading at lyle.smu.edu/emis.)
4. **Qualifying Examination:** At or near the completion of the coursework, the supervisory committee conducts the qualifying examination. This exam ordinarily involves a series of take-home exams, but the format is left to the discretion of the supervisory committee. The qualifying examination is concluded by an oral exam at which time the student is expected to present a proposal for the dissertation. A written proposal must be given to the supervisory committee prior to the oral exam. Upon passing this exam, the student is admitted to doctoral candidacy. Step 4 requires completion of the form Admission to Candidacy.
5. **Dissertation Defense:** The most distinguishing characteristic of a program leading to the Ph.D. degree is the requirement that the candidate write a dissertation embodying the results of a significant and original investigation. The dissertation must make a significant contribution to the systems engineering discipline, and it is expected to be a mature and competent piece of writing. The defense, which is conducted orally, must enable the supervisory committee to satisfy itself that the dissertation is an original piece of research work, that it

has been carried out in keeping with the highest standards of investigation and reporting and that it makes a contribution to knowledge that is of value to the scientific community. Satisfactory performance on this defense constitutes the last academic requirement to be met for the Ph.D. degree. Step 5 requires completion of the form Report on Thesis or Dissertation and/or Final Examination.

Doctor of Engineering (Major in Engineering Management)

This degree is designed to provide students with preparation to meet doctoral standards in an applied science or engineering practice. Applied science as a focus for the doctoral degree refers to the study of advanced theory and its application to a practical problem in order to test and verify performance limitations. The degree requires a high level of expertise in the theoretical aspects of relevant scientific principles and experience with details of the implementation of theory on realistic problems. Engineering practice as a focus for the degree is the study of different aspects that play a role in the transfer of technology, from its inception in research to the intended engineering environment, as well as relevant economic issues. (For information on general degree requirements, see the separate Doctor of Engineering Degree section in this catalog.)

Admission Requirements

Applicants are required to satisfy these requirements:

1. A Master's degree in a technical area from a U.S. college or university accredited by a regional accrediting association or completion of an international degree that is equivalent to a U.S. Master's degree from a college or university of recognized standing.
2. Excellent academic performance in all completed coursework, with a minimum GPA of 3.0 on a 4.0 scale.
3. Submission of a complete application, including a statement of purpose, official transcripts for all previous undergraduate and graduate studies and payment of appropriate application fee.
4. Official GRE graduate school entry exam test results with a minimum 80th-percentile quantitative score.
5. Three letters of recommendation from individuals who can judge the applicant's potential success as a doctoral student.
6. Graduates from foreign countries are required to submit a notarized financial certification form. All international students whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English language proficiency score before being considered for admission as follows:
   - 550 – paper-based examination.
   - 213 – computer-based examination.
   - 59 – Internet-based examination.
7. Approval by the director of the engineering management graduate program.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the Doctor of Engineering degree, candidates are required to satisfy the following:

1. **Twenty-four term hours of engineering management.** These hours must come from graduate-level courses in quantitative and qualitative aspects of managing in a modern technical environment. Courses in the areas of engineering

management, management science, operations research, operations management, production management and other related fields may qualify.

2. **Eighteen term hours in a technical specialty.** These hours must be taken in an engineering or other technical area consistent with anticipated doctoral work demands.
3. **Nine term hours of business/economics.** These hours must come from courses in a graduate program. They should expand the student's understanding of the economic issues and problems relating to the transfer and management of technology.
4. **Fifteen term hours of electives.** All elective hours must come from graduate-level courses and must be approved by the advisory committee. These courses should, in some way, complement and strengthen the student's degree plan.
5. **Twelve term hours of praxis.** These hours must be taken in residence. The student enrolls for these hours in the course of preparing the praxis project.

The following courses, or their equivalents, are included in the degree plan:

Engineering Management

EMIS 7362 Production Systems Engineering
EMIS 8361 Engineering Economics and Decision Analysis
EMIS 8362 Engineering Accounting
EMIS 8363 Engineering Finance
EMIS 8364 Engineering Management

Operations Research

EMIS 8360 Operations Research Models
EMIS 8378 Optimization Models for Decision Support

and one of the following:

EMIS 8371 Linear Programming
EMIS 8373 Integer Programming
EMIS 8374 Network Flows

Statistics

EMIS 7370 (STAT 5340) Probability and Statistics for Scientists and Engineers
EMIS 7377 (STAT 5377) Statistical Design and Analysis of Experiments

A course may not be counted toward more than one category. The minor requirements may be satisfied by transfer credit.

6. **Satisfactory completion of the preliminary counseling examination.** An oral exam covering degree fundamentals. The exam should be scheduled after the student has taken courses in production systems engineering, engineering management, engineering economics, and decision analysis and operations research models, but before 24 term hours have been completed. Questions are drawn predominantly from the graduate courses EMIS 7362, 8360 and 8361. If the student fails the exam, he or she may retake it once. Since the goal of the exam is to detect weaknesses in the student's background, the examiners may grant a conditional or partial pass. Such a pass indicates that the student's weaknesses can be overcome by taking specific courses. In this situation, the student need not retake the exam but will be required to take one or more courses and achieve a grade of *B* or better.
7. **Satisfactory completion of the doctoral qualifying examination.**
8. **Satisfactory completion and defense of the doctoral praxis.**

Certificate Series in Systems Engineering

The systems engineering certificate series is a subset of the systems engineering M.S. degree program, designed for the engineering professional seeking education to support focused career objectives. It presents a series of steps for acquiring basic systems-engineering knowledge and skills, followed by education in one or more focus areas. Each certificate is comprised of selected graduate-level courses from the systems-engineering curriculum, which can form the foundation of a subsequent Master's degree.

Admission Requirements

Applicants are required to satisfy these requirements:

1. A Bachelor of Science in engineering, mathematics or one of the quantitative sciences. A minimum GPA of 3.0 on a scale of 4.0 in previous undergraduate and graduate study.
2. A minimum of two years of college-level mathematics, including at least one year of calculus.
3. Students not meeting these requirements may be admitted on a conditional basis and required to take articulation (bridging) courses for undergraduate credit.

Certificate Requirements

Completion of the courses specified for the individual certificate with a minimum GPA of 3.0 on a scale of 4.0 for those courses.

The three tiers are as follows:

1. **Core curriculum.** A student may earn two certificates by successfully completing prescribed courses that comprise the core courses of Master of Science degree with a major in systems engineering. The certificates are:

   Certificate in Systems Engineering Fundamentals. Designed to provide the student a thorough understanding of the fundamentals of systems engineering, it consists of three courses: EMIS 7301, EMIS 7303 and EMIS 7307.

   Certificate in Systems Analysis. Designed to provide the student a variety of systems analysis methods with selected application to system analyses and optimization, it consists of two courses: EMIS 7300 and EMIS 7305.

2. **Specialty curricula.** After completing the core curriculum, the student may take additional courses to earn specialty certificates. The certificates are: certificate in systems design and development (EMIS 7310 and EMIS 7312) and certificate in reliability and logistics systems engineering (EMIS 7369 or EMIS 7330 and EMIS 7340). Each of these certificate programs comprises two courses beyond the core and gives the student a thorough understanding in a focus area. Additional certificates may be defined as new courses are added.
3. **Master's degree.** The student may apply for admission to the Master's degree program at any point in the certificate series. After admission, graduate courses successfully completed in the certificate series may be applied toward the Master's degree as applicable.

Certificate in Systems Engineering Fundamentals (nine term credit hours)

EMIS 7301 Systems Engineering Process
EMIS 7303 Integrated Risk Management
EMIS 7307 Systems Integration and Test

Certificate in Systems Analysis (six term credit hours)

EMIS 7300 Systems Analysis Methods
EMIS 7305 Systems Reliability, Supportability and Availability Analysis

Certificate in Systems Design and Development (six term credit hours)
EMIS 7310 Systems Engineering Design
EMIS 7312 Software Systems Engineering

Certificate in Reliability and Logistics Systems Engineering (six term credit hours)
EMIS 7369 Reliability Engineering *or* EMIS 7330 Systems Reliability Engineering
EMIS 7340 Logistics Systems Engineering

Certificate Series in Information Engineering and Management

SMU's EMIS department offers a series of certificates in information engineering and management. Each certificate consists of selected graduate-level courses from the Master's of Science in information, engineering and management degree program and can form the foundation of a subsequent Master's degree. The certificates are:

Certificate in Information Engineering Fundamentals is designed to provide the student a thorough understanding of the fundamentals of information engineering and management and consists of three courses: EMIS 7351, EMIS 7352 and EMIS 7353.

Certificate in Information Engineering and Management is designed to provide the student training in strategies and decision-support methodologies and consists of three courses: EMIS 7360, EMIS 8356 and EMIS 7357.

Certificate in Information Technology Governance and Controls provides an extensive background in IT governance and IT controls topics and consists of three courses: EMIS 7360, EMIS 7380 and EMIS 7382.

Master's degree. The student may apply for admission to the Master's degree program at any point in the certificate series. After admission, graduate courses successfully completed in the certificate series may be applied toward the Master's degree as applicable.

Admission Requirements

Admission to a certificate program requires the applicant to have:

1. A Bachelor's degree in an engineering or technical discipline (The technical requirement may be waived with sufficient relevant work experience.) and an undergraduate GPA of 3.0 or higher on a 4.0 scale.
2. Students not meeting these requirements may be admitted on a conditional basis and required to take articulation (bridging) courses for undergraduate credit.

Certificate Requirements

Individual certificates require completion of the specified courses with a minimum GPA of 3.0 on a scale of 4.0:

Certificate in Information Engineering Fundamentals (nine term credit hours):
EMIS 7351 Enterprise Fundamentals*
EMIS 7352 Information System Architecture*
EMIS 7353 Information System Design Strategies

Certificate in Information Engineering Strategy (nine term credit hours):
EMIS 7360 Management of Information Technology*
EMIS 8356 Information Engineering and Global Perspectives*
EMIS 7357 Decision-Support Systems*

Certificate in Information Technology Governance and Controls (nine term credit hours):
EMIS 7360 Management of Information Technology*

EMIS 7380 Managing Information Technology Controls
EMIS 7382 Information Technology Security and Risk Management

The Courses (EMIS)

7300. Systems Analysis Methods. Introduction to modeling and analysis concepts, methods and techniques used in systems engineering, design of products and associated production and logistics systems, and analysis of operational system performance. Includes probabilistic and statistical methods, Monte Carlo simulation, optimization techniques, applications of utility and game theory, and decision analysis.

7301. Systems Engineering Process. The discipline, theory, economics and methodology of systems engineering. A review of the historical evolution of the practice of systems engineering and the principles that underpin modern systems methods. Emphasis on the economic benefits of investment in systems engineering and the risks of failure to adhere to sound principles. Develops an overview perspective distinct from the traditional design- and analytical-specific disciplines.

7303. Integrated Risk Management. An introduction to risk management based upon integrated trade studies of program performance, cost and schedule requirements. Includes risk planning, risk identification and assessment, risk handling and abatement techniques, risk impact analysis, management of risk handling and abatement, and subcontractor risk management. Examines integrated risk management methods, procedures and tools.

7305. Systems Reliability, Supportability and Availability Analysis. An introduction to systems reliability, maintainability, supportability and availability modeling and analysis with an application to systems requirements definition and systems design and development. Covers both deterministic and stochastic models. Emphasis on RMS/A analyses to establish a baseline for systems performance and to provide a quantitative basis for systems tradeoffs. *Prerequisite:* EMIS 7300 or equivalent.

7307. System Integration and Test. The process of successively synthesizing and validating larger and larger segments of a partitioned system within a controlled and instrumented framework. System integration and test is the structured process of building a complete system from its individual elements and is the final step in the development of a fully functional system. Stresses the significance of structuring and controlling integration and test activities. Presents formal methodologies for describing and measuring test coverage, as well as sufficiency and logical closure for test completeness. Discusses interactions with system modeling techniques and risk management techniques. The subject material is based upon principles of specific engineering disciplines and best practices, which form a comprehensive basis for organizing, analyzing and conducting integration and test activities.

7310. Systems Engineering Design. An introduction to system design of complex hardware and software systems. Includes design concept, design characterization, design elements, reviews, verification and validation, threads and incremental design, unknowns, performance, management of design, design metrics and teams. Centers on the development of real-world examples.

7312 (CSE 7312). Software Systems Engineering. Focuses on the engineering of complex systems that have a strong software component. For such systems, software often assumes functions previously allocated to mechanical and electrical subsystems, changing the way systems engineers must think about classical systems issues. Provides a framework for addressing systems engineering issues by focusing on the Software Engineering Institute's Systems Engineering Capability Maturity Model. Includes deriving and allocating requirements, system and software architectures, integration, interface management, configuration management, quality, verification and validation, reliability and risk.

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* *Required for the Master of Science in information engineering and management degree. Certificates are issued following completion of the certificate requirements and submission of the required administrative forms.*

7315. Systems Architecture Development. A design-based methodological approach to system architecture development using emerging and current enterprise architecture frameworks. Includes structured analysis and object-oriented analysis and design approaches; enterprise architecture frameworks, including the Zachman framework, FEAF, DoDAF and ANSI/IEEE-1471; executable architecture model approaches as tools for system-level performance evaluation and tradeoff analyses; case studies in enterprise architecture development; and the integration of architecture design processes into the larger engineering-of-systems environment. *Prerequisite:* EMIS 7301.

7318. Systems Engineering Planning and Management. A practical coverage of tasks, processes, methods and techniques to establish the process of systems engineering and its role in the planning and management of programs. The tasks and roles of program manager and systems engineers for establishing program operations and communications frameworks. Techniques for developing an integrated program/project plan by defining the role of the systems integrator and identifying useful tools for planning and managing systems integration of various sized projects. The student learns to prepare for and successfully complete key program milestone reviews by identifying essential material content and proving the design basis. The course leads the student through the systems development process by showing how to plan for and manage change by implementing methods for configuration, change and risk management. The program life cycle is covered by planning the transition of systems engineering processes from development to production and field support. *Prerequisite:* EMIS 7301.

7320. Systems Engineering Leadership. Augments the management principles embedded in the systems engineering process with process design and leadership principles and practices. Emphasis on leadership principles by introducing the underlying behavioral science components, theories and models. Demonstrates how the elements of systems engineering, project management, process design and leadership integrate into an effective leadership system. *Prerequisite:* EMIS 7301.

7330. Systems Reliability Engineering. An in-depth coverage of tasks, processes, methods and techniques for achieving and maintaining the required level of system reliability considering operational performance, customer satisfaction and affordability. Includes establishing system reliability requirements, reliability program planning, system reliability modeling and analysis, system reliability design guidelines and analysis, system reliability test and evaluation, and maintaining inherent system reliability during production and operation.

7331 (CSE 7330). File Organization and Database Management. A survey of current database approaches and systems and of principles of design and use of these systems. Query language design and implementation constraints. Applications of large databases. A survey of file structures and access techniques. Use of a relational database management systems to implement a database design project. *Prerequisite:* CSE 3358.

7335. Human-Systems Integration (HSI). The understanding and application of cognitive science principles, analysis-of-alternatives methods and engineering best practices for addressing the role of humans within the design of high-technology systems. In addition, HSI-specific processes (e.g., task-centered design; human-factors engineering; manpower, personnel and training; process analysis; usability testing and assessment). *Prerequisite:* EMIS 7301.

7340. Logistics Systems Engineering. An introduction to concepts, methods and techniques for engineering and development of logistics systems associated with product production/manufacturing, product order and service fulfillment, and product/service/customer support, using system engineering principles and analyses. Includes logistics systems requirements, logistics systems design and engineering concurrently with product and service development, transportation and distribution, supply/material support, supply Web design and management, and product/service/customer support.

7347. Critical Infrastructure Protection/Security Systems Engineering. Systems engineering concepts as applied to the protection of the United States' critical infrastructure. A top-level systems viewpoint provides a greater understanding of this system-of-systems. Includes the definition and advantages of SE practices and fundamentals; system objectives

that include the viewpoint of the customer, user and other stakeholders; the elements of the CI and their interdependencies; and the impact of transportation system disruptions and systems risk analysis. *Prerequisites:* EMIS 7301 and EMIS 7303.

7350 (CSE 7350). Algorithm Engineering. Algorithm design techniques. Methods for evaluating algorithm efficiency. Data structure specification and implementation. Applications to fundamental computational problems in sorting and selection, graphs and networks, scheduling and combinatorial optimization, computational geometry, and arithmetic and matrix computation. Introduction to parallel algorithms. Introduction to computational complexity and a survey of NP-complete problems. *Prerequisite:* CSE 3358.

7351. Enterprise Fundamentals. An overview of business fundamentals, spanning the range of all functional areas: management, marketing, operations, accounting, information systems, finance and legal studies. Credit is not allowed for both EMIS 7351 and EMIS 8364.

7352. Information System Architecture. The architecture of an information system defines that system in terms of components and interactions among those components. Addresses IS hardware and communications elements for information engineers, including computer networking and distributed computing. Also, the principles, foundation technologies, standards, trends and current practices in developing an appropriate architecture for Web-based and non-Internet information systems.

7353. Information System Design Strategies. The fundamentals of software engineering and data base management systems for information engineers. The principles, foundation technologies, standards, trends and current practices in data-centric software engineering and systems design, including object-oriented approaches and relational DBMS. Focuses on system design, development and implementation aspects, not on the implementation in code.

7357. Decision-Support Systems. The development and implementation of a data-centric, decision-support systems, the underlying technologies, and current applications and trends. Includes decision making, DSS components, optimization models, expert systems, data mining and visualization, knowledge discovery, and management and executive information systems. *Prerequisite:* EMIS 7360. EMIS 8360 is recommended but not required.

7359. Information Engineering Seminar. Topics in management of information in specific industries or application areas. May be repeated for credit when the topics vary. *Prerequisite:* EMIS 7360.

7360. Management of Information Technologies. Defines the management activities of the overall computer resources within an organization or government entity. Consists of current topics in strategic planning of computer resources, budgeting and fiscal controls, design and development of information systems, personnel management, project management, rapid prototyping and system life cycles.

7361. Computer Simulation Techniques. Introduction to the design and analysis of discrete probabilistic systems using simulation. Emphasizes model construction and a simulation language. *Prerequisites:* Programming ability and introduction to probability or statistics.

7362. Production Systems Engineering. Applies principles of engineering, or "design under constraint," to modern production systems. Includes production systems analysis and design considerations, systems design and optimization models and methods, pull- and push-based production systems, quality engineering and process improvement, plus techniques for engineering and managing systems with specific architectures: batch-oriented, continuous-flow, projects and just-in-time. *Prerequisite:* EMIS 8360 is recommended.

7363. Applied Parallel Programming. Surveys the theory and emphasizes the practice of developing efficient applications software for parallel computers. Includes a survey of parallel processing architectures and machines, elements of parallel programming (process creation, synchronization, communication and scheduling), alternative parallel programming schemes (languages and language enhancements) and implementation of scientific and industrial applications. *Prerequisite:* FORTRAN or C programming.

7364 (STAT 5344). Statistical Quality Control. An introduction to statistical quality control methods that can be applied to meet the demand for ever-increasing levels of product and service quality. Basic methods and tools for analyzing, controlling and improving product

and service quality. Probabilistic and statistical techniques as applied to modeling and analysis of variability associated with product production and service processes. Analysis of product design tolerances, Six Sigma techniques, statistical analysis of process capability and statistical process control using control charts, quality improvement and acceptance sampling. *Prerequisite:* EMIS 4340 (STAT 4340) or EMIS 5370 (STAT 5340).

7365. Program and Project Management. Development of principles and practical strategies for managing projects and programs of related projects for achieving broad goals. Includes planning, organizing, scheduling, resource allocation, strategies, risk management, quality, communications, tools and leadership for projects and programs.

7366. Marketing Engineering. Marketing engineering moves beyond traditional conceptual approaches to embrace the use of analytics, data, information technology and decision models to help organizations effectively reach customers and make marketing decisions. Designed for technical individuals, the course applies engineering problem-solving approaches and computer tools to solve marketing problems from today's competitive work environment. *Prerequisites:* EMIS 4340 (STAT 4340) or EMIS 5370, 7370 (STAT 5340) and EMIS 3360 or 8360 (or equivalent).

7369. Reliability Engineering. Introduction to reliability engineering concepts, principles, techniques and methods required for design and development of affordable products and services that meet customer expectations. Includes reliability concepts and definitions, figures-of-merit, mathematical models, design analysis and trade studies, reliability testing including types of tests, test planning and analysis of test results, and statistical analysis of reliability data. *Prerequisite:* EMIS 4340 (STAT 4340) or EMIS 5370 (STAT 5340).

7370 (STAT 5340). Probability and Statistics for Scientists and Engineers. An introduction to fundamentals of probability, probability distributions and statistical techniques used by engineers and physical scientists. Includes basic concepts and rules of probability, random variables, probability distributions, expectation and variance, sampling and sampling distributions, statistical analysis techniques, statistical inference–estimation and tests of hypothesis, correlation and regression, and analysis of variance. *Prerequisite:* MATH 2339.

7377 (STAT 5377). Design and Analysis of Experiments. Introduction to statistical principles in the design and analysis of industrial experiments. Completely randomized, randomized complete and incomplete block, Latin square and Plackett-Burman screening designs. Complete and fractional experiments. Descriptive and inferential statistics. Analysis of variance models. Mean comparisons. *Prerequisite:* EMIS 4340 (STAT 4340) and senior-standing with a science or engineering major or permission of the instructor.

7380. Managing Information Technology Controls. Current practices in information technology governance and controls, with approaches for balancing business needs with technology controls for high-risk processes. Includes introduction to technology controls, the process of IT governance, systems and infrastructure life cycle management, IT delivery, and support and records management. *Prerequisite:* EMIS 7360.

7382. Information Technology Security and Risk Management. Designed for IT managers and executives with decision-making responsibility in information security governance and risk management. Includes information security organizations and policies, governance, program development and management, information risk management, legal and regulatory compliance, and business continuity planning. *Prerequisite:* EMIS 7360.

8098. Seminar. Seminars and colloquia given by the resident faculty and invited guests in various specialized, as well as general, topics in operations research, engineering management, systems engineering and information engineering.

8305. Systems Life Cycle Cost and Affordability Analysis. Provides an understanding of systems affordability concepts and the life cycle cost process. Examines the importance of using these concepts in optimizing engineering/business decisions with emphasis being placed on the evaluation of alternatives weighing costs, risks, reliability, maintainability, supportability, weight, performance and other benefit/risk parameters. Includes total ownership cost, estimating methods and techniques, cost analysis process, system trade studies, sensitivity analysis, risk analysis and simulation, and system cost effectiveness. *Prerequisites:* EMIS 7301, 7303 and 7305.

8307. Systems Test and Evaluation. An in-depth coverage of the test and evaluation techniques that have evolved in response to the increasing complexity and interdependency of systems. Examines types of testing (such as developmental and operational) as well as the tailoring of testing based on the end user (such as commercial or military). Covers the T&E process, from requirements analysis through test conduct and reporting, as well as the various types of associated documentation. Also, test techniques associated with different disciplines (such as software, reliability and human factors). The course concludes with a review of the best practices in systems T&E. *Prerequisites:* EMIS 7301 and EMIS 7307.

8310. Collective System Design. The design of sustainable and robust systems within organizations. Collective system design enhances Lean and Six Sigma based implementations to ensure long-term sustainability and robustness. Some people call the collective system design methodology and principles "next generation Lean" as it applies systems engineering principles to the design of organizational processes and systems. Applies the design to a wide range of commercial and governmental systems in the areas of manufacturing, product engineering, contract and program management, service industries and business systems. A class project with a local business or agency enables students to practice the application of CSD. *Prerequisites:* EMIS 7301, EMIS 7310 and EMIS 8342.

8315. Innovation in Systems Design. A foundation of modern theory and practice of product innovation in three parts. First, a review of the typical barriers to disruptive innovation: technological, organizational and market-driven. Second, cases of fast innovation with a focus on systems and technology. Third, the system engineer's role in innovation with such methods as quality function deployment, axiomatic design, the theory of inventive problem solving and basic intellectual property protection. The students will practice methods and explore and develop disruptive innovation in a class project. *Prerequisites:* EMIS 7301 and EMIS 7310.

8330 (CSE 8330). Advanced Database Management Systems. An extensive investigation of distributed databases and implementation issues. Included are design, data replication, concurrency control and recovery. Includes implementation project. *Prerequisite:* EMIS 7331.

8331 (CSE 8331). Data Mining. Various data mining concepts and algorithms from a database perspective. Historical background and related topics. An overview of data mining core topics (such as classification, clustering and association rules) and more advanced topics (such as temporal and spatial data, scalability and parallelization, and outliers). Includes linear regression, distance measure, decision trees and neural nets. Case studies and projects. *Prerequisite:* EMIS 7331.

8337 (CSE 8337). Information Retrieval. Examination of techniques used to store and retrieve unformatted/textual data. Examination of current research topics of data mining, data warehousing, digital libraries, hypertext and multimedia data. *Prerequisite:* EMIS 7331.

8340. Systems Engineering Tools. Computerized tools perform the vital function of capturing and delivering systems engineering information throughout the product development life cycle. A survey of the many tools, methods and techniques that are applied to engineering systems from inception to disposal: scope/needs evaluation, requirements analysis, functional and physical allocation, optimization, test validation/verification and product management. Hands-on use of systems engineering software will enable students to identify and apply appropriate tools throughout the life cycle of a product they develop. *Prerequisite:* EMIS 7301.

8342. Six Sigma for Systems Engineering. Methods and tools for the application of Six Sigma concepts as a part of the systems engineering design process for developing quality products. Includes assessing the "predicted quality" of a product through requirements analysis, development of a quantitative process based on engineering best practice and its application to trade studies, model development and operations analysis. *Prerequisites:* EMIS 7301 and EMIS 7303.

8348. Supply-Chain Systems Engineering. An introduction to supply-chain design, development and management concepts and principles from a systems perspective. Includes the system life cycle; influences of reliability, maintainability and supportability and risk analysis associated with supply-chain design, development and management; supply-chain management strategies; high-level supply-chain and transportation concepts; and theories and

deterministic system modeling based on customers' needs, requirements and functional analysis. *Prerequisites:* EMIS 7301, EMIS 7303 and EMIS 7340.

8350 (CSE 8350). Algorithms II. Analysis of dynamic data structures, lower bound theory, problem equivalence and reducibility, complexity theory, probabilistic algorithms, machine models of sequential and parallel computation, and parallel algorithms. *Prerequisite:* EMIS 7350.

8355 (CSE 8355). Graph Theory: Algorithms and Applications. Development of algorithmic and computational aspects of graph theory, with application of concepts and techniques to solving problems of connectivity, set covering, scheduling, shortest paths, traveling salesmen, network flow, matching and assignment. *Prerequisite:* EMIS 7350 (CSE 7350) or permission of the instructor.

8356. Information Engineering and Global Perspectives. An examination of global and information aspects of technology-based and information-based companies. Includes modern business processes, the strategic use of information technology and integration of global information resources for competitive advantage. *Prerequisite:* EMIS 7360.

8358. Technical Entrepreneurship. Development of principles and practical strategies for the management and evolution of rapidly growing technical endeavors. Includes entrepreneurship, intrapreneurship, strategic planning, finance, marketing, sales, operations, research and development, manufacturing and management of technology-based companies. Management teams are formed, and ventures are selected and simulated during an extended period of time. Extensive student presentations and reports. *Prerequisite:* Permission of the instructor.

8360. Operations Research Models. A survey of models and methods of operations research. Deterministic and stochastic models in a variety of areas. Credit is not allowed for both EMIS 3360 and EMIS 8360. *Prerequisites:* A knowledge of linear algebra and an introduction to probability and statistics.

8361. Engineering Economics and Decision Analysis. Introduction to economic analysis methodology. Includes engineering economy and cost concepts, interest formulas and equivalence, economic analysis of alternatives, technical rate of return analysis and economic analysis under risk and uncertainty. Credit is not allowed for both EMIS 2360 and EMIS 8361. *Prerequisite:* Introductory probability.

8362. Engineering Accounting. An introduction to and overview of financial and managerial accounting for engineering management. Includes basic accounting concepts and terminology, preparation and interpretation of financial statements and uses of accounting information for planning, budgeting, decision making, control and quality improvement. Focuses on concepts and applications in industry today.

8363. Engineering Finance. Develops an understanding of corporate financial decisions for engineers. Includes cost of capital, capital budgeting, capital structure theory and policy, working capital management, financial analysis and planning, and multinational finance. *Prerequisite:* EMIS 8361 or a knowledge of time value of money.

8364. Engineering Management. How to manage technology and technical functions from a pragmatic point of view. How to keep from becoming technically obsolete as an individual contributor and how to keep the corporation technically astute. A look at the management of technology from three distinct viewpoints: 1) the management of technology from both an individual and a corporate perspective, 2) the management of technical functions and projects and 3) the management of technical professionals within the organization. *Prerequisite:* Graduate standing in engineering.

8368. Enterprise Leadership. The study of how companies link strategy and action at the enterprise level: shaping and leveraging the work performed by the multifirm enterprises that jointly produce added value for customers, while building and retaining competencies critical for competitive advantage.

8371. Linear Programming. A complete development of theoretical and computational aspects of linear programming. *Prerequisite:* MATH 3353.

8372 (STAT 6372). Queuing Theory. Queuing theory provides the theoretical basis for the analysis of a wide variety of stochastic service systems. The underlying stochastic processes are Markov and renewal processes. The course has two objectives: to cover the fundamentals of stochastic processes necessary to analyze such systems and to provide the basics of formulation and analysis of queuing models with emphasis on their performance characteristics. *Prerequisite:* EMIS 7370 (STAT 5340) or permission of the instructor.

8373. Integer Programming. A presentation of algorithms for linear integer programming problems. Includes complexity analysis, cutting plane techniques and branch-and-bound. *Prerequisite:* EMIS 8360 or EMIS 8371.

8374. Network Flows. A presentation of optimization algorithms and applications modeling techniques for network flow problems. Includes pure, generalized, integer and constrained network problems, plus special cases of each, including transportation, assignment, shortest-path, transshipment, multi-commodity and nonlinear networks. Uses case studies to illustrate the uses of network models in industry and government settings. Prerequisite or corequisite: EMIS 8360 or EMIS 8371.

8378. Optimization Models for Decision Support. Study of the design and implementation of decision support systems based on optimization models. Course objectives: development of modeling skills, practice in the application of operations research techniques, experience with state-of-the-art software and the study of decision support systems design and management. Includes linear, integer, network, nonlinear, multi-objective and stochastic optimization models for manufacturing, logistics, telecommunications, service operation and public sector applications. *Prerequisite:* EMIS 8360 or equivalent.

8380. Mathematics for Optimization. Presents, at a high level of mathematical rigor, the background topics that are necessary for a good understanding of the theoretical underpinnings of optimization. Many of these topics are traditionally higher-level linear algebra topics that are not present in undergraduate and most basic graduate linear algebra courses. A thorough review of traditional supporting material covering real-valued functions in multidimensional space. Includes theoretical material supporting linear programming and nonlinear programming. Uses MATLAB for examples and projects. Homework will consist primarily of the construction of proofs. *Prerequisite:* Knowledge of linear algebra and analysis at the advanced calculus level.

8381. Nonlinear Programming. Includes convexity analysis, nonlinear duality theory, Kuhn-Tucker conditions, algorithms for quadratic programming and separable programming: gradient and penalty methods. *Prerequisite:* EMIS 8371.

8382. Theory of Optimization. Lagrange multiplier theory and fixed-point representations. Duality/convex analysis/subgradient relationship. *Prerequisite:* EMIS 8371.

8(0–4)90, 8(0–4)93. Graduate Seminar. Special and intensive study of selective topics in operations research, engineering management, systems engineering or information engineering, aimed at encouraging students to follow recent developments through regular critical reading of the literature.

8(1–4)94, 8(1–4)95. Selected Problems. Independent investigation of topics in operations research, engineering management, systems engineering and information engineering. Must be approved by the department chair and the major professor. *Prerequisite:* 12 term hours of graduate credit.

7(0,1,2,3,6)96. Master's Thesis. Variable credit, but not more than six term hours in a single term and not more than four in each summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, four term hours of thesis would require registration in EMIS 7396 and 7196.

8(0,1,2,3,6)96. Dissertation. Variable credit, but not more than 15 term credit hours in a single term and not more than 10 term credit hours in a summer term. Registration in several sections may be needed to obtain the desired number of dissertation hours. For example, 12 term credit hours of dissertation would require registration in EMIS 8396 and EMIS 8996.

ENVIRONMENTAL AND CIVIL ENGINEERING

Professor Jeffrey W. Talley, **Chair**

Professors: Bijan Mohraz, Jeffrey W. Talley. **Associate Professors:** Paul Krueger (Mechanical Engineering), David A. Willis (Mechanical Engineering). **Research Associate Professor:** Alfredo Armendariz. **Assistant Professors:** Khaled Abdelghany, Usama El Shamy, Jim T. Yu. **Senior Lecturer:** Roger O. Dickey. **Visiting Lecturer:** Jong-Wha Bai. **Adjunct Faculty:** Arthur Beck, Mark K. Boyd, Gerald R. Carney, Robert Casagrande, Weiping Dai, Betsy del Monte, James Duke, Ted Dumas, John Easton, Carl Edlund, Fawzi Elghadamsi, Andrew Felder, Edward Forest (Retired Chair), Anwar Hirany, Louis Hosek, Ron Jackson, Timothy L. Jacobs, James E. Langford, Donald L. Legg, Paul Martin, Shannon McCall, Jennifer O'Brien, Jon D. Rauscher, D. Blair Spitzberg, John Stanley, Bennett Stokes, Patricia Taylor, Ken Thomas, Philip K. Turner, Dan Wittliff, Scott Woodrow. ***Emeritus*** **Professor:** Cecil H. Smith.

Graduate programs in the Department of Environmental and Civil Engineering educate and train leaders in the fields of environmental protection, resource management, engineering design, and construction and facilities management. Programs are tailored to the individual needs and interests of students, so that students with interests in studying global climate change, protecting the quality of drinking water, designing the next generation of high-rise buildings or smart highways, managing commercial buildings, or managing large institutional and industrial facilities receive the training they need to excel in their careers.

Environmental and civil engineering are inextricably linked. While civil engineering focuses on the infrastructure of modern society, environmental engineering is concerned with the well-being and health of people and the environment. Environmental and civil engineering entered the early 1900s as a single integrated discipline, when it was critical to address sanitary problems to protect public health and to develop regional water supplies and the civil infrastructure to support rapid urbanization and early industrialization. Separate disciplines gradually emerged, evolving and broadening to address the overall quality and function of modern society – preserving the environment while enabling the realization of an enriched life through technology.

Graduate Degrees

Master of Science in Environmental Engineering
Master of Science in Environmental Science
(Major in Environmental Science)
Master of Science in Environmental Science
(Major in Environmental Systems Management)
Master of Science in Environmental Science
(Major in Hazardous and Waste Materials Management)
Master of Science in Civil Engineering
Master of Science in Facilities Management
Doctor of Philosophy (Major in Civil Engineering)

Professional Certificates

Air Quality Engineering
Environmental Management and Compliance
Facilities Management
Hazardous and Waste Materials Management
Occupational Health and Industrial Hygiene
Pollution Control and Prevention
Sustainability
Water Quality Management

Environmental Engineering and Environmental Science Programs. Today, the environmental field is dynamic and wide-ranging, comprising many different disciplines and professional roles. Environmental engineering and science involve not only traditional water and wastewater management, but also the management of hazardous and radioactive materials, pollution prevention and waste minimization, innovative hazardous waste treatment and site remediation processes, environmental and occupational health, resource conservation and recovery, sustainable development of natural resources and air quality management, and air pollution control. In addition, modern manufacturing, both domestic and worldwide, is focusing on products fabricated from recycled and natural materials that are both competitive and harmlessly degraded in the environment. The trend toward global manufacturing will grow stronger in the years ahead. Environmental challenges presented by this movement must be overcome if the economic and lifestyle benefits of globalization are to be extended to all people of the world.

SMU's environmental engineering and environmental science programs prepare graduates for professional and academic careers dealing with a broad spectrum of environmental issues: 1) surface and groundwater quality management, 2) environmental systems and process modeling, 3) environmental chemistry and biology, 4) wastewater management, 5) solid-waste management, 6) hazardous and waste materials management, 7) atmospheric systems and air-pollution control, and 8) environmental and occupational health.

As a complement to these broadly based environmental programs, professionally oriented Master of Science degrees focused in the specific areas of environmental systems management and hazardous and waste materials management are offered by the Department of Environmental and Civil Engineering.

Civil Engineering and Facilities Management Programs. Civil engineers are engaged in planning, design, construction, maintenance and management of the infrastructure of modern society. They are responsible for the design of water-supply and wastewater treatment systems; transportation systems such as highways, railways, waterways, mass transit, airports, ports and harbors; dams, reservoirs and hydroelectric power plants; thermoelectric power plants; transmission and communication towers; high-rise buildings; and even aircraft and aerospace structures, shuttles and space stations. Every major structure critical to this country and global society depends on the work of civil engineers.

As a complement to the civil engineering program, a professionally oriented Master of Science degree in facilities management is offered by the Department of Environmental and Civil Engineering. Management of constructed facilities has expanded considerably in scope and complexity during the last 30 years. Today, the breadth and diversity of capabilities and services required to support the built environment include elements of engineering disciplines such as civil, electrical, mechanical and environmental; architecture; and the management fields of financial analysis, accounting, planning, life-cycle analysis and asset management, and human resources. Critical systems include electrical power, heating/air conditioning, fire protection and security, communication and data transmission, gas and liquid delivery, environmental response procedures, and waste disposal. In more complex industrial and medical care facilities, this would also include disposal of radioactive and hazardous waste, disposal of toxic gases, waste treatment often including in-house incineration, and the design and installation of redundant emergency systems to limit losses due to electrical/mechanical failure. Facilities such as airports, hospitals, hotels, manufacturing plants, office buildings, schools, shopping malls, and universities and colleges all require increasingly complex systems and controls.

The civil engineering and facilities management programs prepare graduates for professional and academic careers through a focus in the following areas: 1) structural analysis and design, 2) geomechanics and foundations, 3) water and wastewater treatment, 4) surface and groundwater quality management, 5) construction management, and 6) facilities management.

Contact Information. For more information about graduate programs in environmental engineering, environmental science, environmental systems management, hazardous and waste materials management, civil engineering, and facilities management, visit the Department of Environmental and Civil Engineering at www.lyle.smu.edu/ence or call 214-768-3894. For additional points of contact and enrollment information, visit the Lyle School of Engineering at www.smu.edu/Lyle/graduate.aspx or call 214-768-1817.

Distance Learning. All Master of Science degrees offered by the Department of Environmental and Civil Engineering are available to distance learning students. The distance learning program is managed by the Lyle School of Engineering and is available to students throughout the United States and many foreign countries. Lectures are available via streaming video on the Internet and, in some cases, DVDs of current lectures are forwarded to students on a regular, weekly basis.

Master of Science in Environmental Engineering

The Master of Science in environmental engineering emphasizes engineering analysis and design of both technological and management-oriented solutions to environmental problems, while broadly addressing the fundamental science and regulatory aspects of the field. A minimum of 30 term credit hours beyond the baccalaureate degree is required. For full-time graduate students, six term credit hours may involve research and completion of a thesis, with approval from the student's adviser, with an additional 24 term credit hours of coursework. The program also has the flexibility to meet the needs of part-time students, already working in industry, who typically take the nonthesis route requiring 30 term credit hours of coursework. All environmental graduate courses are offered in the evening and via distance learning to accommodate the busy schedules of working professionals.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy these additional requirements:

1. Bachelor of Science in one of the engineering disciplines or in a quantitative science closely related to environmental engineering.
2. A minimum of one year of college-level calculus. An additional half-year of differential equations is desirable.
3. A minimum of one year of college-level chemistry. An additional half-year of organic chemistry is desirable.
4. A solid background in the fundamental engineering sciences, including thermodynamics and fluid mechanics, is desirable.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy these additional requirements:

1. 30 term credit hours, with a minimum graduate GPA of 3.0 on a 4.0 scale. Additional articulation courses may be required for students without rigorous engineering undergraduate degrees.

2. Satisfactory completion of the core curriculum consisting of five courses (15 term credit hours):

   ENCE 7312 Risk Assessment and Health Effects
   ENCE 7313 Environmental Chemistry and Biology
   ENCE 7322 Biological Waste Treatment
   ENCE 7331 Air Pollution Management and Engineering
   ENCE 7354 Environmental Engineering Principles and Processes

3. Satisfactory completion of three Group I specialization electives (nine term credit hours) chosen from environmental engineering courses and related engineering disciplines, including:

   ENCE 7321 Physical and Chemical Waste Treatment
   ENCE 7325 Disaster Management
   ENCE 7332 Groundwater Hydrology and Contaminants
   ENCE 7334 Fate and Transport of Contaminants
   ENCE 7335 Aerosol Mechanics
   ME 7336 Intermediate Fluid Dynamics
   EMIS 7370 (STAT 5340) Probability and Statistics for Scientists and Engineers

4. Satisfactory completion of two Group II breadth electives (six term credit hours) chosen from civil engineering, environmental science, environmental systems management, hazardous and waste materials management, and engineering management courses, including:

   ENCE 7311 Environmental and Hazardous Waste Law
   ENCE 7314 Environmental Regulations and Compliance
   ENCE 7315 Integrated Waste Management
   ENCE 7323 Project Management
   ENCE 7350 Introduction to Environmental Management Systems
   ENCE 7351 Introduction to Environmental Toxicology
   ENCE 7352 Management of Radioactive Hazards
   ENCE 7353 Environmental Epidemiology
   ENCE 7372 Introduction to CAD
   ENCE 7378 Transportation Planning and Traffic Engineering
   ENCE 7(0,1,2,3,6)96 Thesis
   EMIS 8360 Operations Research Models
   EMIS 8361 Economic Decision Analysis
   EMIS 8362 Engineering Accounting
   EMIS 8363 Engineering Finance
   EMIS 8364 Management for Engineers
   EMIS 8378 Optimization Models for Decision Support

Master of Science in Environmental Science (Major in Environmental Science)

The Master of Science in environmental science emphasizes the fundamental science and regulatory framework of the environmental field, while broadly addressing analysis and design of both technological and management-oriented solutions to environmental problems. A minimum of 30 term credit hours beyond the baccalaureate degree is required. For full-time graduate students, six term credit hours may involve research and completion of a thesis, with approval from the student's adviser, with an additional 24 term credit hours of coursework. The program also has the flexibility to meet the needs of part-time students, already working in industry, who typically take the nonthesis route requiring 30 term credit hours of

coursework. All environmental graduate courses are offered with evening class times and via distance learning to accommodate the busy schedules of working professionals.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy these additional requirements:

1. Bachelor of Science in one of the quantitative sciences, mathematics or in one of the engineering disciplines.
2. A minimum of one year of college-level calculus. An additional half-year of differential equations is desirable.
3. A minimum of one year of college-level chemistry. An additional half-year of organic chemistry is desirable.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy these additional requirements:

1. 30 term credit hours, with a minimum graduate GPA of 3.0 on a 4.0 scale. Additional articulation courses may be required for students without an environmental, or closely related quantitative science or engineering, undergraduate degree.
2. Satisfactory completion of the required core curriculum consisting of five courses (15 term credit hours):

   ENCE 7312 Risk Assessment and Health Effects
   ENCE 7313 Environmental Chemistry and Biology
   ENCE 7322 Biological Waste Treatment
   ENCE 7331 Air Pollution Management and Engineering
   ENCE 7354 Environmental Engineering Principles and Processes

3. Satisfactory completion of three Group I specialization electives (nine term credit hours) chosen from environmental science and regulatory framework courses, including:

   ENCE 7311 Environmental and Hazardous Waste Law
   ENCE 7351 Introduction to Environmental Toxicology
   ENCE 7353 Environmental Epidemiology
   BIOL (CHEM) 5110 Biological Chemistry Laboratory
   BIOL (CHEM) 5310 Biological Chemistry: Macromolecular Structure and Function
   BIOL 5311 Biological Chemistry: Metabolism
   BIOL 5364 Endocrine Physiology
   CHEM 5486 Instrumental Analysis
   GEOL 5370 Global Change
   GEOL 5384 Hydrogeology
   GEOL 5386 Geochemistry
   GEOL 6369 Advanced Geochemistry
   GEOL 6370 Aquatic and Mineral-Water Interface Geochemistry

4. Satisfactory completion of two Group II breadth electives (six term credit hours) chosen from civil engineering, environmental engineering, environmental systems management, hazardous and waste materials management, and engineering management courses, including:

ENCE 7314 Environmental Regulations and Compliance
ENCE 7315 Integrated Waste Management
ENCE 7321 Physical and Chemical Waste Treatment
ENCE 7323 Project Management
ENCE 7325 Disaster Management
ENCE 7332 Groundwater Hydrology and Contamination
ENCE 7334 Fate and Transport of Contaminants
ENCE 7335 Aerosol Mechanics
ENCE 7350 Introduction to Environmental Management Systems
ENCE 7352 Management of Radioactive Hazards
ENCE 7378 Transportation Planning and Traffic Engineering
ENCE 7(0,1,2,3,6)96 Thesis
EMIS 8360 Operations Research Models
EMIS 8361 Economic Decision Analysis
EMIS 8362 Engineering Accounting
EMIS 8363 Engineering Finance
EMIS 8364 Management for Engineers
EMIS 8378 Optimization Models for Decision Support

Master of Science in Environmental Science (Major in Environmental Systems Management)

The Master of Science in environmental science, with a major in environmental systems management, emphasizes management-oriented solutions to environmental problems and regulatory compliance issues. A minimum of 30 term credit hours beyond the baccalaureate degree is required. The program was specifically developed to meet the needs of part-time students already working in industry. Accordingly, the required 30 term credit hours of coursework are interdisciplinary, stressing an integrated approach to the field. All environmental and engineering management graduate courses are offered with evening class times and via distance learning to accommodate the busy schedules of working professionals.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy these additional requirements:

1. Bachelor of Science in one of the quantitative sciences, mathematics or in one of the engineering disciplines.
2. A minimum of one year of college-level calculus. An additional half-year of differential equations is desirable.
3. A minimum of one year of college-level chemistry. An additional half-year of organic chemistry is desirable.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy these additional requirements:

1. 30 term credit hours, with a minimum graduate GPA of 3.0 on a 4.0 scale. Additional articulation courses may be required for students without an environmental, or closely related quantitative science or engineering, undergraduate degree.

2. Satisfactory completion of the core curriculum consisting of eight courses (24 term credit hours):

   ENCE 7311 Environmental and Hazardous Waste Law
   ENCE 7312 Risk Assessment and Health Effects
   ENCE 7313 Environmental Chemistry and Biology
   ENCE 7315 Integrated Waste Management
   ENCE 7323 Project Management
   ENCE 7331 Air Pollution Management and Engineering
   ENCE 7350 Introduction to Environmental Management Systems
   ENCE 7352 Management of Radioactive Hazards

3. Satisfactory completion of one technical elective (three term credit hours) chosen from among the following environmental engineering, environmental science, and hazardous and waste materials management courses:

   ENCE 7314 Environmental Regulations and Compliance
   ENCE 7321 Physical and Chemical Waste Treatment
   ENCE 7322 Biological Waste Treatment
   ENCE 7325 Disaster Management
   ENCE 7332 Groundwater Hydrology and Contamination
   ENCE 7334 Fate and Transport of Contaminants
   ENCE 7335 Aerosol Mechanics
   ENCE 7351 Introduction to Environmental Toxicology
   ENCE 7353 Environmental Epidemiology
   ENCE 7354 Environmental Engineering Principles and Processes

4. Satisfactory completion of one management elective (three term credit hours) chosen from among the following engineering management courses:

   EMIS 8361 Economic Decision Analysis
   EMIS 8362 Engineering Accounting
   EMIS 8363 Engineering Finance
   EMIS 8364 Management for Engineers

Master of Science in Environmental Science (Major in Hazardous and Waste Materials Management)

The Master of Science in environmental science, with a major in hazardous and waste materials management, emphasizes the science and technology being developed to solve the environmental problems attributable to hazardous and waste materials. The management, treatment and elimination of these materials, including regulatory and compliance issues, are central to this program. The program was specifically developed to meet the needs of part-time students, already working in industry. Accordingly, the required 30 term credit hours of coursework are interdisciplinary, stressing an integrated approach to the field. All environmental and engineering management graduate courses are offered with evening class times and via distance learning to accommodate the busy schedules of working professionals.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy these additional requirements:

1. Bachelor of Science in one of the quantitative sciences, mathematics or in one of the engineering disciplines.
2. A minimum of one year of college-level calculus. An additional half-year of differential equations is desirable.

3. A minimum of one year of college-level chemistry. An additional half-year of organic chemistry is desirable.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy these additional requirements:

1. 30 term credit hours, with a minimum graduate GPA of 3.0 on a 4.0 scale. Additional articulation courses may be required for students without an environmental, or closely related quantitative science or engineering, undergraduate degree.
2. Satisfactory completion of the core curriculum consisting of eight courses (24 term credit hours):

   ENCE 7311 Environmental and Hazardous Waste Law
   ENCE 7312 Risk Assessment and Health Effects
   ENCE 7313 Environmental Chemistry and Biology
   ENCE 7314 Environmental Regulations and Compliance
   ENCE 7315 Integrated Waste Management
   ENCE 7322 Biological Waste Treatment
   ENCE 7323 Project Management
   ENCE 7354 Environmental Engineering Principles and Processes

3. Satisfactory completion of one environmental elective (three term credit hours) chosen from among the following environmental engineering, environmental science and environmental systems management courses:

   ENCE 7321 Physical and Chemical Waste Treatment
   ENCE 7325 Disaster Management
   ENCE 7331 Air Pollution Management and Engineering
   ENCE 7332 Groundwater Hydrology and Contamination
   ENCE 7334 Fate and Transport of Contaminants
   ENCE 7335 Aerosol Mechanics
   ENCE 7350 Introduction to Environmental Management Systems
   ENCE 7351 Introduction to Environmental Toxicology
   ENCE 7352 Management of Radioactive Hazards
   ENCE 7353 Environmental Epidemiology

4. Satisfactory completion of one management elective (three term credit hours) chosen from among the following engineering management courses:

   EMIS 8361 Economic Decision Analysis
   EMIS 8362 Engineering Accounting
   EMIS 8363 Engineering Finance
   EMIS 8364 Management for Engineers

Master of Science in Civil Engineering

The Master of Science in civil engineering offers two areas of emphasis, structural engineering and transportation systems management, while offering breadth in the areas of geotechnical engineering, water and wastewater treatment and facilities management. A minimum of 30 term credit hours beyond the baccalaureate degree is required. For full-time graduate students, six term credit hours may involve research and completion of a thesis, with approval from the student's adviser, with an additional 24 term credit hours of coursework. The program also has the flexibility to meet the needs of part-time students, already working in industry, who typically take the

nonthesis route with 30 term credit hours of coursework. All civil engineering graduate courses are offered with evening class times and via distance learning to accommodate the busy schedules of working professionals.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy the following additional requirement:

Bachelor of Science in civil engineering or a closely related engineering discipline.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy these additional requirements:

1. 30 term credit hours, with a minimum graduate GPA of 3.0 on a 4.0 scale. Additional articulation courses may be required for students without a civil engineering undergraduate degree.
2. Given the multidisciplinary nature of civil engineering, the core curriculum and elective courses comprising the degree plans for Master of Science students will vary, depending on the student's undergraduate background and his or her desired area of specialization. These are sample degree plans for students who have a civil engineering undergraduate degree and want to specialize in either structural engineering or transportation systems management:

Sample Degree Plan – Structural Engineering

Satisfactory completion of the core curriculum consisting of five courses (15 term credit hours):

ENCE 7340 Introduction to Solid Mechanics
ENCE 7361 Matrix Structural Analysis and Introduction to Finite Element Methods
ENCE 7373 Prestressed Concrete
ENCE 7375 Advanced Concrete Design
ENCE 7377 Advanced Steel Design

Satisfactory completion of five elective courses (15 term credit hours) chosen from structural analysis, structural design, geotechnical engineering, transportation systems management and facilities management courses:

ENCE 7325 Disaster Management
ENCE 7365 Introduction to Construction Management
ENCE 7372 Introduction to CAD
ENCE 7378 Transportation Planning and Traffic Engineering
ENCE 7385 Advanced Soil Mechanics
ENCE 7386 Foundation Engineering
ENCE 7(0,1,2,3,6)96 Thesis
ENCE 8340 Theory of Elasticity
ENCE 8364 Finite Element Methods in Structural and Continuum Mechanics
ENCE 8366 Basic Concepts of Structural Stability
ENCE 8368 Theory of Plate Behavior
ENCE 8379 Analysis of Transportation Systems

Sample Degree Plan – Transportation Systems Management

Satisfactory completion of the core curriculum consisting of five courses (15 term credit hours):

ENCE 7323 Project Management
ENCE 7378 Transportation Planning and Traffic Engineering
ENCE 7391 Special Projects (Topics in Transportation Engineering)
ENCE 8379 Analysis of Transportation Systems
EMIS 8360 Operations Research Models

Satisfactory completion of three specialization electives (nine term credit hours) chosen from the following courses:

EMIS 7340 Logistics Systems Engineering
EMIS 7370 (STAT 5340) Probability and Statistics for Scientists and Engineers
EMIS 8361 Economic Decision Analysis
EMIS 8371 Linear Programming
STAT 6336 Statistical Analysis

Satisfactory completion of two breadth electives (six term credit hours) chosen from the following courses:

ENCE 7331 Air Pollution Management and Engineering
ENCE 7350 Introduction to Environmental Management Systems
ENCE 7365 Introduction to Construction Management
ENCE 7(0,1,2,3,6)96 Thesis
CSE 7345 Advanced Java Programming
CSE 7365 (MATH 5315) Introduction to Numerical Analysis
CSE 8355 Graph Theory: Algorithms and Applications
EMIS 7377 (STAT 5377) Design and Analysis of Experiments
EMIS 8373 Integer Programming
EMIS 8374 Network Flows

Master of Science in Facilities Management

The Master of Science in facilities management emphasizes architectural and structural design, planning, energy management, engineering systems, environmental issues, and financial and asset management. The program was specifically developed to meet the needs of part-time students already working in industry. Accordingly, the required 30 term credit hours of coursework are interdisciplinary, stressing an integrated approach to the field. All facilities management, civil engineering and environmental graduate courses are offered in the evening and via distance learning to accommodate the busy schedules of working professionals.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy the following additional requirement:

Bachelor of Science in engineering, science or business or a baccalaureate degree in another discipline and relevant facilities experience.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy the following additional requirements:

1. 30 term credit hours, with a minimum graduate GPA of 3.0 on a 4.0 scale. Additional articulation courses may be required for students with a nonquantitative undergraduate degree.

2. Satisfactory completion of the core curriculum consisting of five courses (15 term credit hours):

   ENCE 7363 Architectural and Structural Engineering
   ENCE 7366 Introduction to Facilities Engineering Systems
   ENCE 7370 Facility Planning
   ENCE 7371 Facility Financial and Asset Management
   ENCE 7384 Energy Management for Buildings

3. Satisfactory completion of three Group I specialization electives (nine term credit hours) chosen from facilities management courses:

   ENCE 7365 Introduction to Construction Management
   ENCE 7367 Telecommunications in Facilities Planning
   ENCE 7368 Facilities Contract Management
   ENCE 7369 Electrical, Mechanical and Piping Systems for Buildings
   ENCE 7383 Heating, Ventilating and Air Conditioning
   ENCE 8365 Construction Methods and Rehabilitation
   ENCE 8370 Facility Project Management

4. Satisfactory completion of two Group II breadth electives (six term credit hours) chosen from civil engineering, environmental systems management, hazardous and waste materials management, and engineering management courses, including:

   ENCE 7311 Environmental and Hazardous Waste Law
   ENCE 7315 Integrated Waste Management
   ENCE 7325 Disaster Management
   ENCE 7331 Air Pollution Management and Engineering
   ENCE 7340 Introduction to Solid Mechanics
   ENCE 7352 Management of Radioactive Hazards
   ENCE 7372 Introduction to CAD
   EMIS 7360 Management of Information Technologies
   EMIS 7369 Reliability Engineering
   EMIS 8361 Economic Decision Analysis
   EMIS 8362 Engineering Accounting
   EMIS 8363 Engineering Finance
   EMIS 8364 Management for Engineers
   ME 7368 Project and Risk Management

Doctor of Philosophy (Major in Civil Engineering)

Admission Requirements

Applicants are required to satisfy these requirements:

1. Master of Science degree in civil engineering, environmental engineering or a closely related discipline in engineering or the physical sciences from a U.S. college or university accredited by a regional accrediting association, or completion of an international degree that is equivalent to a U.S. Master's degree from a college or university of recognized standing.
2. Excellent academic performance in all completed coursework, with a minimum GPA of 3.0 on a 4.0 scale.
3. Submission of a complete application, including a statement of purpose, official transcripts for all previous undergraduate and graduate studies, and payment of appropriate application fee.

4. Official GRE graduate school entry exam scores greater than 650 quantitative and 550 verbal
5. Three letters of recommendation from individuals who can judge the applicant's potential success as a doctoral student.
6. Graduates from foreign countries are required to submit a notarized financial certification form. All international students whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English language proficiency score before being considered for admission:
   - 550 – paper-based examination.
   - 213 – computer-based examination.
   - 59 – Internet-based examination.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the Doctor of Philosophy degree, candidates are required to satisfy the following:

1. At least 54 term credit hours of coursework beyond the baccalaureate degree.
2. A minor of at least 12 term credit hours providing breadth and support to the doctoral program.
3. 24 term credit hours of dissertation.
4. Written and oral doctoral qualifying examinations.
5. A written dissertation.
6. Defense of the dissertation.
7. The major and minor courses comprising a degree plan for a doctoral student will be determined by the student's advisory committee. These plans will vary among students depending on their background and dissertation research topic. These are sample degree plans for students who have been admitted to the Ph.D. program with an engineering Master of Science degree and have an interest in structural engineering, air pollution control and atmospheric science, or water and wastewater engineering:

Sample Degree Plan – Structural Engineering Track

Major Courses

ENCE 7340 Introduction to Solid Mechanics
ENCE 7361 Matrix Structural Analysis and Introduction to Finite Element Methods
ENCE 7364 Introduction to Structural Dynamics
ENCE 7373 Prestressed Concrete
ENCE 7375 Advanced Concrete Design
ENCE 7377 Advanced Steel Design
ENCE 8364 Finite Element Methods in Structural and Continuum Mechanics

Minor Courses

ENCE 7385 Advanced Soil Mechanics
ENCE 7386 Foundation Engineering
Advanced courses in geological sciences, mathematics and statistical science

Alternative Major and Minor Courses

ENCE 7325 Disaster Management
ENCE 7362 Engineering Analysis With Numerical Methods
ENCE 8340 Theory of Elasticity
ENCE 8368 Theory of Plate Behavior

Sample Degree Plan – Air Pollution Control and Atmospheric Sciences Track

Major Courses

ENCE 7312 Risk Assessment and Health Effects
ENCE 7313 Environmental Chemistry and Biology
ENCE 7331 Air Pollution Management and Engineering
ENCE 7335 Aerosol Mechanics
ENCE 7352 Management of Radioactive Hazards
ME 7336 Intermediate Fluid Dynamics

Minor Courses

EMIS 7377 (STAT 5377) Design and Analysis of Experiments
STAT 6336 Statistical Analysis
STAT 6337 Statistical Analysis II
STAT 6345 Linear Regression

Alternative Major and Minor Courses

ENCE 7314 Environmental Regulations and Compliance
ENCE 7321 Physical and Chemical Waste Treatment
ENCE 7325 Disaster Management
ENCE 7354 Environmental Engineering Principles and Processes
GEOL 5370 Global Change

Sample Degree Plan – Water and Wastewater Engineering Track

Major Courses

ENCE 7313 Environmental Chemistry and Biology
ENCE 7322 Biological Waste Treatment
ENCE 7332 Groundwater Hydrology and Contamination
ENCE 7334 Fate and Transport of Contaminants
ENCE 7354 Environmental Engineering Principles and Processes
EMIS 7377 Design and Analysis of Experiments

Minor Courses

ENCE 7312 Risk Assessment and Health Effects
ENCE 7351 Introduction to Environmental Toxicology
BIOL (CHEM) 5311 Biological Chemistry: Metabolism
BIOL 5364 Endocrine Physiology

Alternative Major and Minor Courses

ENCE 7311 Environmental and Hazardous Waste Law
ENCE 7315 Integrated Waste Management
ENCE 7321 Physical and Chemical Waste Treatment
ENCE 7325 Disaster Management
ENCE 7350 Introduction to Environmental Management Systems
ENCE 7353 Environmental Epidemiology

Professional Certificates

Professional certificates are comprised of subsets of courses from ENCE Master of Science degree programs, specifically tailored for technical and management professionals seeking education to further their careers. Each certificate requires completion of three courses (nine term credit hours) chosen from a focused set of graduate-level courses, creating a solid foundation for further graduate study leading to a Master of Science degree if the student desires.

Admission Requirements

Students must have an undergraduate degree in science or engineering or five years of directly relevant professional experience. Students who complete the

professional certificate and meet other graduate admissions requirements can later apply for admission as a degree-seeking student in one of the graduate degree programs. For students subsequently admitted to a graduate degree program, the courses taken to complete the professional certificate will also count toward the graduate degree requirements.

Certificate Requirements

Students are required to satisfy these requirements:

1. 9 term credit hours, with a minimum graduate GPA of 3.0 on a 4.0 scale.
2. Courses must be completed within three years from admission to the certificate program.
3. Satisfactory completion of the core and elective courses specified for the individual certificate:

Air Quality Engineering

Core courses:

ENCE 7331 Air Pollution Management and Engineering
ENCE 7335 Aerosol Mechanics

Plus one of the following electives:

ENCE 7312 Risk Assessment and Health Effects
ENCE 7352 Management of Radioactive Hazards
ENCE 7353 Environmental Epidemiology

Environmental Management and Compliance

Core courses:

ENCE 7314 Environmental Regulations and Compliance
ENCE 7350 Introduction to Environmental Management Systems

Plus one of the following electives:

ENCE 7311 Environmental and Hazardous Waste Law
ENCE 7323 Project Management

Facilities Management

Any three of the following courses:

ENCE 7363 Architectural and Structural Engineering
ENCE 7366 Introduction to Facilities Engineering Systems
ENCE 7370 Facility Planning
ENCE 7371 Facility Financial and Asset Management
ENCE 7384 Energy Management for Buildings

Hazardous and Waste Materials Management

Core courses:

ENCE 7315 Integrated Waste Management
ENCE 7323 Project Management

Plus one of the following electives:

ENCE 7311 Environmental and Hazardous Waste Law
ENCE 7312 Risk Assessment and Health Effects
ENCE 7314 Environmental Regulations and Compliance

Occupational Health and Industrial Hygiene

Any three of the following courses:

ENCE 7312 Risk Assessment and Health Effects
ENCE 7335 Aerosol Mechanics
ENCE 7351 Introduction to Environmental Toxicology
ENCE 7353 Environmental Epidemiology
ENCE 7392 Special Topics: Fundamentals of Industrial Hygiene

Pollution Control and Prevention

Any three of the following courses:

ENCE 7315 Integrated Waste Management
ENCE 7322 Biological Waste Treatment
ENCE 7331 Air Pollution Management and Engineering
ENCE 7354 Environmental Engineering Principles and Processes

Sustainability

Core courses:

ENCE 7328 Introduction to Sustainability
ENCE 7329 Methods and Technology for Sustainability
ENCE 7330 Design for Sustainability

Water Quality Management

Any three of the following courses:

ENCE 7313 Environmental Chemistry and Biology
ENCE 7322 Biological Waste Treatment
ENCE 7332 Ground Water Hydrology and Contamination
ENCE 7334 Fate and Transport of Contaminants
ENCE 7354 Environmental Engineering Principles and Processes

Department Facilities

Departmental offices and instructional and research laboratories are located in the new, state-of-the-art J. Lindsay Embrey Engineering Building. Environmental teaching and research laboratories include dedicated space for air quality and meteorology, industrial hygiene, environmental microbiology, and water quality. The air quality/meteorology and water quality laboratories are capable of conducting sophisticated chemical analyses of air samples and assessing the quality of water supplies and wastes and the effectiveness of water and waste treatment procedures. Major equipment includes several spectrophotometers, including atomic absorption, inductively coupled plasma emission for low-level heavy metals analysis and two Hewlett-Packard gas chromatographs. Other equipment includes continuous ambient air monitoring equipment, an ultraviolet/visible spectrophotometer, pH and other specific ion meters, incubating ovens, microscopes, furnaces, centrifuges, dissolved oxygen meters, a Mettler titrator for chemical and acid/base surface experiments, several temperature control baths and a tumbler for constant temperature studies. The air quality and meteorology laboratory includes state-of-the-art airflow, pressure and volume measurement instrumentation. The industrial hygiene laboratory includes an inventory of the latest state-of-the-art personal monitoring equipment for assessing occupational exposure to a variety of industrial process stressors, including: asbestos, noise, total and respirable dust, metals, radiation and heat stress.

Civil engineering teaching and research laboratories include dedicated space for mechanics of materials and structural engineering, hydraulics and hydrology, soil mechanics and geotechnical engineering, and transportation materials and intelligent transportation systems. Mechanics of materials/structural engineering lab equipment includes a tension-compression testing machine with automatic data acquisition instrumentation and computer software, a torsion test machine, a bending test machine, and a set of impact test equipment. Major hydraulics/hydrology laboratory equipment includes a 5-meter open channel flume with various accessories (such as undershot weir, rotary undershot gate, and sharp and broad-crested weirs), a basic hydraulics bench for fundamental fluid mechanics experiments (such as hydrostatic pressure forces, Bernoulli's theorem and pipe friction losses) and a hydrology study

system for hydrology experiments (such as simulating rainfall over watersheds and measuring resulting outflow hydrographs and groundwater flow profiles). The geotechnical engineering laboratory has a fully automated multipurpose testing machine that can be used to conduct triaxial, consolidation, flexible-wall permeability, swelling and unconfined compression tests. The lab also has a fully automated direct shear test machine. Traditional geotechnical testing equipment such as sieve analysis, hydrometer, constant head/falling head permeameter, liquid and plastic limits, compaction, and relative density are also available.

The Embrey Building also houses a dedicated computer-aided design laboratory with AutoCAD software and a general-use computer laboratory that includes personal computers, high-resolution color monitors and laser printers. Computers in both the CAD and general-use laboratories are connected, through a high-speed network, to the computer systems of the Lyle School of Engineering and SMU, as well as off-campus systems via the Internet. The computer network provides access to general applications software and specialized software for engineering problems, including air dispersion modeling, AutoCAD, hydrologic and hydraulic modeling for water resource systems, statistical analysis and stochastic modeling, structural analysis and design, transportation systems planning and analysis, and water quality modeling.

The Courses (ENCE)

7311. Environmental and Hazardous Waste Law. Federal environmental laws, with emphasis on laws dealing with hazardous substances, such as the Comprehensive Environmental Response, Compensation and Liability Act and the Resource Conservation and Recovery Act of 1976; regulations and the regulatory framework; definitions and substantive requirements; roles of the states and the federal Environmental Protection Agency; compliance and enforcement; and case studies.

7312. Risk Assessment and Health Effects. Introduction to toxicology as it relates to environmental and health effects of hazardous materials; toxicological methodology; risk management factors, including legal aspects; human health and ecological risk assessment and risk communication; emergency response; and computer databases.

7313. Environmental Chemistry and Biology. Chemical and biochemical processes; controlling fate and transport of hazardous materials, with emphasis on chemical equilibria; chemical thermodynamics; acid-base equilibria; precipitation and dissolution; oxidation-reduction processes; environmental transformations of organic materials; introductory taxonomy; microbial growth and kinetics; energy transfer; and microbial ecosystems.

7314. Environmental Regulations and Compliance. Practical knowledge of federal and state environmental permitting processes and procedures is provided. Regulatory requirements are reviewed, with emphasis on the Title 40 Code of Federal Regulations for water, air, solid and hazardous waste. Air, water, storm water and waste permits are reviewed, as well as permits-by-rule. Also explored are the consequences of noncompliance with regulations by presenting enforcement options available to government agencies.

7315. Integrated Waste Management. Comprehensive introduction to the fundamentals of the complex interdisciplinary field of hazardous waste management, current management practices, treatment and disposal methods, and site remediation. Topics include detailed case studies and design examples to evaluate the effectiveness of different treatment and containment technologies in addressing today's hazardous waste situations.

7317. Environmental Organic Chemistry. This course will examine the fundamental processes that govern transformations of organic chemicals in natural and engineering systems. The course will be divided into three parts: 1) organic chemistry overview, 2) physical transformations of organic compounds and 3) organic chemical reactions in the environment. The organic chemistry overview will provide knowledge regarding basic properties of organic compounds, such as nomenclature and structures. Physical transformation of organic compounds will provide an understanding of processes (such as sorption and volatilization) that control the distribution of organic chemicals between different phases (such as air, water

and soil). Environmentally mediated reactions (such as hydrolysis and photolysis) that control the breakdown of organic chemicals will be the focus of chemical reactions.

7321. Physical and Chemical Waste Treatment. Waste minimization techniques and objectives are introduced. Chemical equilibrium and chemical reaction kinetics are thoroughly reviewed. Design and analysis equations and procedures are rigorously derived for chemical reactors and physical unit operations. The treatment objectives examined include 1) solids-liquid separation accomplished by coagulation and flocculation, sedimentation, filtration, flotation and solids handling processes; 2) immiscible liquid separation brought about by emulsion-breaking chemicals and gravity and flotation oil/water separators; 3) phase and species transformations through pH neutralization, chemical precipitation, chemical oxidation/reduction, air stripping and solidification/stabilization; and 4) solute separation and concentration achieved with activated carbon absorption, synthetic ion exchange resins and membrane separation techniques.

7322. Biological Waste Treatment. Biological treatment topics include an overview of microbiology and microbial metabolism; kinetics of biological growth; aerobic suspended growth processes, including the various modifications of the activated sludge process, aerated lagoons and sequencing batch reactors; aerobic attached growth processes, including trickling filters, biofilter towers and rotating biological contactors; anaerobic processes, including sludge digestion and liquid waste treatment with the anaerobic contact process and anaerobic filters; biosolids handling and disposal; composting; land treatment; and in situ biotreatment and biotreatment of contaminated soils.

7323. Project Management. Role of project officer; systems and techniques for planning, scheduling, monitoring, reporting and completing environmental projects; total quality management; project team management and development of winning proposals; contract management and logistics; case study application of project management to all environmental media and programs; and community relations, risk communication, crisis management, consensus building, media and public policy.

7325. Disaster Management. This course introduces the student to basic concepts in disaster management. Drawing on a range of sources, from the textbook to the U.S. Disaster Response Plan to research papers, the course covers the fundamentals of preparedness, mitigation, response and recovery. An all-hazards approach is taken, providing analysis of natural, technological and man-made disasters. In addition to discussing basic theories of disaster management, the course introduces the student to key methods in the field, including simulation modeling, consequence analysis tools, design criteria, statistical and case study methods ("lessons learned"), and risk analysis.

7327. Optimization and Reliability for Infrastructure and Environmental Systems. This course introduces the concepts of engineering systems optimization, reliability and risk assessment, and applies them to civil and environmental engineering systems. Topics include an introduction to engineering systems definition, classical methods of optimization, linear programming, integer programming, dynamic programming, nonlinear optimization, and reliability and risk concepts in engineering planning and design. Engineering applications will include transportation networks, fleet assignment, supply-chain management, environmental engineering systems, fluid transport and water reservoir operation, and structural engineering systems. Advanced topics will include an introduction to chance-constrained optimization and basic decomposition approaches and their application to real-world problems. *Prerequisite:* Graduate standing or permission of instructor.

7328. Introduction to Sustainability. This course introduces the student to basic concepts in sustainability. Drawing on a range of sources, including selected books and readings, the course explores the idea of total connectedness of resource use globally, with particular emphasis on the situation in North Texas. The course will address the issues of air quality and energy supply, sustainable construction, water use, transit and other related areas of resource use, and waste generation. Multiple guest lecturers will provide a series of multiple viewpoints and areas of specific expertise. *Prerequisite:* Graduate standing or permission of instructor.

7329. Methods and Technology for Sustainability. This course covers technologies and methods used in sustainable design and analysis. Areas covered include the scientific understanding of alternative energy systems, water reuse and supply, and state-of-the-art materials created for sustainability. Also discussed are methods for assessing sustainability, including life-cycle assessment and the development of sustainable indicators. *Prerequisite:* Graduate standing or permission of instructor.

7330. Design for Sustainability. This course introduces the student to the issues involved in creating a sustainable built environment. The course will address issues of resource use at the regional and project-specific level. Specific techniques for designing and constructing sustainable buildings will be addressed. Systems of measurement for sustainable properties will be discussed on a comparative level, and the United States Green Building Council's Leadership in Energy and Environmental Design (or LEED) system will be specifically addressed. *Prerequisite:* Graduate standing or permission of instructor.

7331. Air Pollution Management and Engineering. This course covers the science, engineering, public health and economic aspects of air quality. Students will develop in-depth understanding and broad knowledge of the sources and properties of air pollutants, air quality management, transport of pollutants in the environment, regulations of air quality, and the operation and design of air-pollution-control systems. In addition, the class will review the current status of science, policy and regulations on several selected topics such as urban smog, regional haze, greenhouse gas and global climate change, stratospheric ozone depletion, and mercury emissions and control. *Prerequisites:* CHEM 1304 General Chemistry, MATH 1337 Calculus With Analytic Geometry I or equivalent and PHYS 1303 Introductory Mechanics or equivalent.

7332. Groundwater Hydrology and Contamination. Groundwater hydrology; aquifer and well hydraulics; flow equations and models; implications for landfill design; sources and nature of groundwater contaminants; monitoring and analysis; contaminant fate and transport; transport model for hazardous substances; groundwater pollution control measures; containment and treatment; and groundwater quality management. *Prerequisite:* MATH 2343 Elementary Differential Equations.

7333. Laboratory Methods in Environmental Engineering. This course provides students with hands-on, state-of-the-art experience with important experimental methods in environmental systems, evaluating the reliability and significance of parameter determinations. Covers instrumental and statistical methods used for characterization of water, air and soil quality. Introduction to treatability studies, including reactor dynamics. The course format provides two hours of lecture and three hours of laboratory component. *Prerequisite:* ENCE 5313 Environmental Chemistry and Biology or two terms of undergraduate chemistry.

7334. Fate and Transport of Contaminants. Development and application of fate and transport models for waterborne contaminants, with a focus on material balance principle; mass transport and transformation processes; modeling of lakes and reservoirs; stream modeling; general flow case; groundwater models; water-sediment, water-soil and water-air interfaces; multiphase and integrated modeling approaches; and case studies.

7335. Aerosol Mechanics. Fundamental and advanced principles of airborne particles, including their physical properties; aerodynamic behavior; and their collection, measurement and analysis. The course emphasizes the origins and properties of atmospheric aerosols and the design of air pollution equipment. *Prerequisite:* ENCE 3431 Fundamentals of Air Quality I or ENCE 2342 Fluid Mechanics or equivalent.

7340. Introduction to Solid Mechanics. Three-dimensional stress and strain, failure theories, introduction to two-dimensional elasticity, torsion of prismatic members, beams on elastic foundations, introduction to plates and shells, and energy methods. *Prerequisites:* ENCE 2340 Mechanics of Deformable Bodies and MATH 2343 Elementary Differential Equations.

7350. Introduction to Environmental Management Systems. An in-depth introduction to environmental management systems. Includes systems such as the Eco-Management and Audit Scheme, Responsible Care, Occupational Health and Safety Assessment Series 18000, the International Organization for Standardization 14000 standard and the Texas Emergency

Medical Services program. Takes a step-by-step look at the ISO 14001 standard, from the policy statement to the management review and allows students to fully understand the plan-do-check-act approach of the system. Also introduces students to management system auditing, the requirements of a system auditor and the certification process.

7351. Introduction to Environmental Toxicology. Toxicology is presented as it relates to environmental and health effects of hazardous materials. Toxicological methodologies, pharmacokinetics, mechanisms of action to toxicants, origin response to toxic substances and relevant aspects of the occupational and regulatory environment will be examined. Specific topics include toxicology of metals, radiation, industrial solvents and vapors, pesticides, teratogens, mutagens, and carcinogens. Risk communication and risk assessment are examined as they relate to toxic substance exposure.

7352. Management of Radioactive Hazards. Principles of radioactive material production, uses and hazards are presented with emphasis on their safe control and management. Topics in health physics and radiation protection related to the commercial nuclear industry are examined, including uranium fuel production, light water reactor technologies, and industrial and medical uses of radioactive byproduct materials. Risk assessment methods and hazard management connected to the fuel cycles will be developed. The regulation of radioactive materials will be studied with emphasis on licensing of regulated industries, radioactive material transportation, radioactive waste management and disposal, radiological emergency preparedness, and decommissioning. *Prerequisite:* ENCE 7313.

7353. Environmental Epidemiology. Introduction to the science of epidemiology. Design and conduct of studies examining health effects of environmental exposures. Strengths and limitations of research strategies and interpretation of study results. Areas of interest include air and water pollution, lead and biological marker outcomes.

7354. Environmental Engineering Principles and Processes. Waste minimization and pollution prevention techniques and objectives are introduced. A comprehensive study is made of biological, chemical and physical principles and treatment strategies for controlling pollutant emissions. Equal emphasis is placed on underlying theory and practical engineering applications of both common and innovative water and wastewater treatment processes. Design equations, procedures and process models are rigorously derived for chemical/biological reactors and physical unit operations. Emphasis is placed on engineering analysis and application of process modeling techniques for design of unit processes to achieve specific treatment objectives. *Prerequisites:* CHEM 1303 General Chemistry, MATH 2343 Elementary Differential Equations, ENCE 2304 Introduction to Environmental Engineering and Science, and ENCE 2342 Fluid Mechanics.

7361. Matrix Structural Analysis and Introduction to Finite Element Methods. A systematic approach to formulation of force and displacement method of analysis, representation of structures as assemblages of elements, and computer solution of structural systems. *Prerequisite:* ENCE 3350 Structural Analysis or equivalent.

7362. Engineering Analysis With Numerical Methods. Applications of numerical and approximate methods in solving a variety of engineering problems. Examples include equilibrium, buckling, vibration, fluid mechanics, thermal science and other engineering applications. *Prerequisite:* Permission of instructor.

7363. Architectural and Structural Engineering. The basic principles of structural analysis and mechanics of deformable bodies are introduced. Structural systems and principles are presented with an emphasis on architectural design. Students will be provided with a conceptual introduction to structures emphasizing the integration of structural and architectural design. Case studies of buildings are presented and discussed. *Prerequisites:* ENCE 2310 Statics and ENCE 2320 Dynamics.

7364. Introduction to Structural Dynamics. Dynamic responses of structures and behavior of structural components to dynamic loads and foundation excitations, single- and multidegree-of-freedom systems response and its applications to analysis of framed structures, and an introduction to systems with distributed mass and flexibility. *Prerequisite:* MATH 2343 Elementary Differential Equations.

7365. Introduction to Construction Management. Construction practice techniques and current technological tools are examined. Included are cost estimating, bidding, contracts and contract bonds, risk and umbrella excess insurance, labor law, and labor relations. Building codes and regulations are examined. Business methods with respect to managing project time and cost, including typical forms used in construction, are addressed.

7366. Introduction to Facilities Engineering Systems. The interrelationships of fire protection; heating, ventilation and air conditioning; electrical; plumbing, lighting; telecommunications; and energy management systems for buildings are examined. A life-cycle approach examines each of these systems with respect to cost, durability, maintainability, operability and safety. Facility operations, facility maintenance and testing, and assessments are discussed.

7367. Telecommunications in Facility Planning. A thorough description of telecommunications technology is presented. Provides the student with a working knowledge of the fundamental concepts of telecommunications technology for both voice and data. Topics presented include digital communications, standards and protocols, Ethernets, local area networks, fiber optics, and voice technologies.

7368. Facilities Contract Management. Provides a critical foundation and understanding of terminology, arts and skills of insurance and risk management as well as contracts and contract negotiation, review and preparation. Attention is also given to lease analysis, licensing and permits, when and how bidding contracts are warranted, how to prepare specifications and their role in contract creation, and supplier and vendor management in the post-contractual process.

7369. Electrical, Mechanical and Piping Systems for Buildings. Mechanical and electrical systems for buildings are examined with emphasis on practical aspects of the subjects. Space planning and architectural considerations, including cost and environmental impact of the mechanical and electrical systems, are presented. *Prerequisites:* Undergraduate introduction to electrical circuits, classical mechanics and fluid dynamics or instructor's approval.

7370. Facility Planning. The overall planning process for construction projects is presented. The three divisions of planning – program planning, project planning and activity planning – are presented in an integrated manner. Included are different modeling approaches for the planning process.

7371. Facility Financial and Asset Management. Financial analysis and reporting as well as concepts and methods of accounting, budgeting and evaluation of projects are examined. The role of facility managers in affecting corporate earnings and valuations is presented. The management of the facility during its entire life cycle, extending from planning and budgeting to the management of its assets and construction projects, is included.

7372. Introduction to CAD. Provides students with hands-on, state-of-the-art experience with computer-aided drafting using AutoCAD to produce drawings used for engineering presentations and construction. Students will learn how to draw lines and curvilinear lines, use blocks and external references, write text, create plot files and employ many other commands necessary to produce engineering drawings as used to construct environmental, civil and structural engineering projects.

7373. Prestressed Concrete. Theory and application of prestressed concrete members, time-dependent deflections and continuous prestressed beams. *Prerequisite:* ENCE 4350 Structural Design or equivalent.

7375. Advanced Concrete Design. Behavior, analysis and design of concrete slender columns, two-way slab systems and deep beams. Yield line analysis for slabs. Design and behavior of shear walls, retaining walls and foundations systems. *Prerequisite:* ENCE 4350 Structural Design or equivalent.

7377. Advanced Steel Design. Behavior and design of steel structures, including general methods of plastic analysis, plastic moment distribution, steel frames, unbraced and braced frames, and composite construction. *Prerequisite:* ENCE 4350 Structural Design or equivalent.

7378. Transportation Planning and Traffic Engineering. This course is concerned mainly with the analysis and modeling of urban transportation systems. The course consists of three main parts. The first part provides an overview of main definitions and terminologies involved in the planning and modeling of urban transportation systems. The second part introduces the concept of urban transportation planning systems along with an overview of various models used in travel demand forecasting. The third part describes principles of traffic operations, analysis and control. *Prerequisite:* Basic principles of probability and statistics.

7383. Heating, Ventilating and Air Conditioning. Examines the science and practice of controlling environmental conditions through the use of thermal processes and systems. Specific applications include refrigeration, psychometrics, solar radiation, heating and cooling loads in buildings, and design of duct and piping systems. Theory and analysis are emphasized. *Prerequisites:* ENCE 2331 Thermodynamics, ENCE 2342 Fluid Mechanics and ME 3332 Heat and Mass Transfer.

7384. Energy Management for Buildings. Procedures to select energy saving options for buildings are examined with emphasis on the practical aspects of the subject. Space planning, architectural considerations, cost and environmental impact of the mechanical and electrical systems are considered along with optimizing the life-cycle cost of the proposed alternative. Software for life-cycle cost and energy analysis is used to calculate energy consumption and compare energy features of proposed, audit-determined feasible changes to a building.

7385. Advanced Soil Mechanics. Physicochemical properties of soil and soil stabilization. Advanced theories of soil deformation and failure as applied to slope stability and lateral loads. Soil-water interaction in earthen dams. *Prerequisite:* ENCE 4385 Soil Mechanics and Foundations.

7386. Foundation Engineering. Application of soil mechanics principles to the design and construction of shallow and deep foundations. Topics include: subsurface investigation procedures to obtain soil parameters for design and construction of structure foundations, bearing capacity and settlement analyses, construction procedures and soil improvement techniques. *Prerequisite:* ENCE 4385 Soil Mechanics and Foundations.

7387. Geotechnical Earthquake Engineering. This course provides fundamental knowledge and practical application of soil dynamics and geotechnical earthquake engineering. Includes an overview of seismic hazards, the fundamentals of vibration, wave propagation in elastic medium, properties of dynamically loaded soils, earthquake-induced ground motion, ground response analysis, lateral earth pressure on retaining walls, liquefaction of soils and seismic stability of earth embankments. *Prerequisite:* ENCE 5364 Introduction to Structural Dynamics or approval of the instructor.

8340. Theory of Elasticity. The study of stress, strain and stress-strain relationships for elastic bodies. Classical solutions of two- and three-dimensional problems. The use of the Airy stress function. *Prerequisite:* ENCE 7340 or equivalent.

8364. Finite Element Methods in Structural and Continuum Mechanics. Theory and application of finite element, two- and three-dimensional elements, bending elements, applications to buckling, and dynamic problems. *Prerequisite:* ENCE 7361.

8365. Construction Methods and Rehabilitation. Basic construction methods and equipment used to rehabilitate existing buildings and structures. Covers building maintenance, space improvement and building component alteration, and installation of utilities including underground utility design. *Prerequisites:* ENCE 7363 and ENCE 7365.

8366. Basic Concepts of Structural Stability. Unified approach to elastic buckling analysis of columns, plates and shells using variational calculus (developed entirely in the course). *Prerequisite:* ENCE 7340 or permission of instructor.

8368. Theory of Plate Behavior. Analysis of flat plates subjected to normal loading, inplane loading and thermal stresses. Analyzes plates of various shapes, thick plates and anisotropic plates for both small and large deflections. *Prerequisite:* ENCE 7340 or permission of instructor.

8370. Facility Project Management. The principles and techniques of project management, beginning with the conceptual phase through coordination of design and construction to project completion. *Prerequisite:* ENCE 7370.

8378. Transportation Demand Analysis. An overview of the theory of discrete choice and applications related to modeling travel demand. Topics include theories of choice behavior, theory of estimation, binary choice models, multinomial choice models, multidimensional choice and nested logic, aggregate forecasting techniques and estimation software. *Prerequisite:* Basic principles of probability and statistics.

8379. Analysis of Transportation Systems. An overview of techniques used to model and analyze transportation systems. Includes queuing theory, graph theory, network modeling, development of algorithms, shortest path problem, vehicle routing problem and simulation techniques. Applications to transportation systems. *Prerequisite:* Basic principles of probability and statistics.

Advanced Special Topics

7090. Seminar. Lectures by invited speakers from industry and academia, including SMU faculty and students, dealing with engineering practice and research topics of current interest in environmental and civil engineering. All students, staff and faculty are invited.

7(1–4)9(1–2). Special Projects. Intensive study of a particular subject or design project, not available in regular course offerings, under the supervision of a faculty member approved by the department chair.

7(0,1,2,3,6)96. Master's Thesis. Variable credit, but no more than six term hours in a single term and not more than four term hours in a summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, four term hours of thesis would require enrollment in ENCE 7396 and ENCE 7196.

8(0,1,3,6,9)96. Dissertation. Variable credit, but no more than 15 term hours in a single term and no more than 10 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of dissertation hours. For example, 12 term hours of dissertation would require registration in ENCE 8396 and ENCE 8996.

8(1–9)9(0–4). Special Topics. Individual or group study of selected topics in environmental or civil engineering. Topics must be approved by the department chair and the instructor.

MECHANICAL ENGINEERING

Professor Volkan Otugen, **Chair**
Professor Radovan Kovacevic, **Director, Research Center for Advanced Manufacturing**

Professors: Yildirim Hürmüzlü, Radovan Kovacevic, José L. Lage, Volkan Otugen, Bijan Mohraz, Peter E. Raad, Wei Tong. **Associate Professors:** Paul S. Krueger, Charles M. Lovas, Edmond Richer, David A. Willis. **Assistant Professor:** Jeong Ho You. **Senior Lecturer:** Dona T. Mularkey. **Lecturers:** Elena Borzova, Donald C. Price. **Adjunct Faculty:** Bogdan Antohe, Eric B. Cluff, Santos Garza, Wade Meaders, David J. Nowacki, Allen D. Tilley, Andy Weaver, Jim Webb. ***Emeritus* Professors:** David B. Johnson, Jack P. Holman, Paul F. Packman, Hal Watson, Jr.

Mechanical engineering is a very diverse, dynamic and exciting field. Because of the wide-ranging technical background they attain, mechanical engineers have the highest potential for employment after graduation and the exceptional mobility that is needed for professional growth even during bear-market conditions.

The Mechanical Engineering Department at SMU has a long tradition of offering a superb engineering education within an environment that fosters creativity and innovation. Small classes, a trademark of the program, not only allow for strong mentoring but also promote academic excellence through cooperation and teamwork. Our exceptionally qualified faculty members are continuously engaged in cutting-edge research projects, facilitating the attainment and transmission of

knowledge to the students. Leading by example, through encouragement and dedication, the faculty is committed to the success of every student during his or her tenure at SMU and after graduation.

The SMU program prepares students to be creative by providing a solid background in fundamentals of science and engineering without compromising the practical aspects of mechanical engineering. Essential entrepreneurial know-how, interpersonal skills and an understanding of the importance of lifelong learning complement the educational experience of SMU students. The program stimulates professional and social leadership by providing, among others, opportunities for students to participate in the SMU student section of the American Society of Mechanical Engineers.

Graduate Degrees

Master of Science in Mechanical Engineering
Master of Science (Major in Manufacturing Systems Management)
Master of Science (Major in Packaging of Electronic and Optical Devices)
Doctor of Philosophy (Major in Mechanical Engineering)

Master of Science in Mechanical Engineering

Mechanical engineers apply their creative knowledge to solve critical problems in several different areas, such as bio-engineering (e.g., drug delivery; artificial organs, prosthetics and orthotics), construction, design and manufacturing, electronics, energy (e.g., production, distribution and conservation), maintenance (individual machinery and complex installations), materials processing, medicine (diagnosis and therapy), national security and defense, packaging, pollution mitigation and control, robotics and automation, sensors, small scale devices, and all aspects of transportation, including space travel and exploration.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to satisfy the following additional requirement:

Bachelor of Science in mechanical engineering or a closely related discipline.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy the following requirements:

The completion of 10 graduate level courses (30 term credit hours) or the completion of eight courses (24 term credit hours) and a Master's thesis.

The Master's thesis must attain a certain level of originality to be considered "independent" work and be presented to, and approved by, a committee that includes at least three members and is chaired by the adviser. Students are required to take five courses (15 term credit hours) from one of the three existing areas of concentration: design and dynamics systems control, mechanical sciences and thermal fluid sciences. In addition, the students must take at least one course from each of the other two areas. The choice of courses must be approved by the academic graduate adviser. These requirements provide depth and breadth to the academic experience of students. The available areas of concentration are:

Design and Dynamic Systems and Controls:

ME 7302 (EE 7362) Linear System Analysis
ME 7314 Introduction to Microelectromechanical Systems (MEMS) and Devices
ME 7320 Intermediate Dynamics
ME 7322 Vibrations
ME 7326 Vehicle Dynamics
ME 7337 Introduction to Computational Fluid Dynamics
ME 7358 Vibration Analysis of Electronic Systems
ME 7372 Introduction to CAD
ME 8367 (EE 8367) Nonlinear Control

Mechanical Science:

ME 7319 Advanced Mechanical Behavior of Materials
ME 7320 Intermediate Dynamics
ME 7322 Vibrations
ME 7323 Introduction to Fracture Mechanics
ME 7324 Fatigue Theory and Design
ME 7340 Introduction to Solid Mechanics
ME 7361 Matrix Structural Analysis
ME 7364 Introduction to Structural Dynamics
ME 8364 Finite Element Methods in Structural and Continuum Mechanics

Thermal and Fluid Sciences:

ME 7330 Heat Transfer
ME 7331 Advanced Thermodynamics
ME 7332 Heat Transfer in Biomedical Sciences
ME 7333 Transport Phenomena in Porous Media
ME 7336 Intermediate Fluid Dynamics
ME 7337 Introduction to Computational Fluid Dynamics
ME 7342 Introduction to the Thermal Management of Electronics
ME 7358 Vibration Analysis of Electronic Systems
ME 7383 Heating, Ventilating and Air Conditioning
ME 7386 Convection Heat Transfer
ME 7394 Laser-Assisted Materials Processing
ME 8385 Conduction Heat Transfer
ME 8387 Radiation Heat Transfer

The best students enrolled in this Master's program are encouraged to participate in research projects conducted by the Lyle School of Engineering faculty and to consider extending their studies toward a Ph.D. degree in mechanical engineering at SMU or elsewhere.

Master of Science
(Major in Manufacturing Systems Management)

Manufacturing is undergoing rapid change. Global competition, rapid advances in manufacturing technology, integration across the enterprise and an expanding role for software are putting pressure on manufacturing businesses from the Fortune 500 to small job shops. Success now requires manufacturing professionals with up-to-date knowledge and skills in these rapidly evolving fields.

Developed in consultation with business and industry leaders and professionals in manufacturing, the SMU M.S. in MSM program is unique in providing both the latest in technology and the broad management skills needed for success in today's business. The interdisciplinary program prepares manufacturing professionals to lead their company in the integration of the entire product commercialization process – including concept, design, manufacturing process development, production and distribution.

The program provides a broad set of business skills to manage this integrated process including strategies, globalization, project management and quality.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to have a Bachelor of Science in one of the engineering disciplines or a closely related scientific field.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy these additional requirements:

These 10 courses are required:

ME 7301 Entrepreneurship and Business Development in Manufacturing
ME 7303 Organizational Leadership
ME 7351 Computer Integrated Manufacturing Systems
ME 7352 Manufacturing Methods and Systems
ME 7353 Manufacturing Management
ME 7354 Lean Manufacturing and Six Sigma
ME 7365 Strategies for Manufacturing Firms
ME 7366 Global Manufacturing
ME 7369 Innovation Management
ME 7382 Finance and the Manufacturing Enterprise

Professional Certificate in Manufacturing Management Fundamentals

A professional certificate may be earned upon the successful completion of three courses selected from this list of four core courses:

ME 7301 Entrepreneurship and Business Development in Manufacturing
ME 7303 Organizational Leadership
ME 7353 Manufacturing Management
ME 7382 Finance and the Manufacturing Enterprise

Admission Requirements

Students must have an undergraduate degree in science or engineering or five years of directly relevant professional experience.

Students who complete the requirements for the professional certificate and meet the admission requirements can apply for admission as a degree-seeking student in the graduate degree program in manufacturing systems management.

For those students accepted into the graduate degree program, the courses taken to complete the professional certificate will count toward the graduate degree requirements.

Completion Requirements

The professional certificate will be awarded upon completion of three of the four core courses with a grade of *B* or better in each of the three courses.

The three courses for the professional certificate must be completed within three years from admission to the program.

Master of Science
(Major in Packaging of Electronics and Optical Devices)

Electronic and optical devices continue their rapid evolution with advanced functionality, smaller individual features and increased complexity. Each step up in the capability of the devices demands ever more creative packages to enable effective communication outside the device, dissipation of increasing amounts of heat and protection of the sensitive device from the environment. The electronic industry

needs packaging engineers with broad technical capabilities. The best packaging engineers have in-depth expertise in mechanics, thermal management, electrical behavior and materials. They also have an understanding of the semiconductor devices being packaged and the manufacturing techniques used to make and package them. This program, developed with input from leaders in the electronics industry, provides this in-depth technical expertise. The four courses cover mechanical aspects of packages, thermal management, electrical characterization, materials effects, design techniques, reliability, semiconductor fundamentals and manufacturing technologies. Students can select from a variety of elective courses in areas such as microelectromechanical systems, design of optoelectronics and fiber optic communications. They will gain knowledge about the leading edge research that is pushing the state-of-the-art in packaging technology and about the practical challenges that the industry is now facing.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for a Master of Science degree, applicants are required to have a Bachelor of Science in one of the engineering disciplines or in a closely related scientific field.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for a Master of Science degree, candidates are required to satisfy the following additional requirements:

1. Satisfactory completion of the required core curriculum consisting of these four courses:

   ME 7334 Fundamentals of Electronic Packaging
   ME 7342 Introduction to Thermal Management of Electronics
   ME 7343 Electronic Packaging Materials: Processes, Properties and Testing
   ME 7358 Vibration Analysis of Electronic Systems

2. Satisfactory completion of five electives chosen from approved electronic packaging specialization courses such as:

   ME 7314 Introduction to Microelectromechanical Systems (MEMS) and Devices
   ME 7335 Convective Cooling of Electronics
   ME 7344 Conductive Cooling of Electronics
   ME 7346 Application of Computational Techniques to the Mechanical and Thermal Design of Electronic Systems
   ME 7348 Thermal, Fluid and Mechanical Measurements in Electronics
   ME 7359 Analysis and Design of Optoelectronic Packaging
   ME 7360 Electronic Product Design and Reliability

3. Satisfactory completion of one elective from this list of courses:

   ME 7354 Lean Manufacturing and Six Sigma
   ME 7363 Electronic Manufacturing Technology

Professional Certificate in Electronic Packaging Fundamentals

A professional certificate may be earned upon the successful completion of three courses selected from the following list of four core courses:

ME 7334 Fundamentals of Electronic Packaging
ME 7342 Introduction to Thermal Management of Electronics
ME 7343 Electronic Packaging Materials: Processes, Properties and Testing
ME 7358 Vibration Analysis of Electronic Systems

Admission Requirements

Students must have an undergraduate degree in science or engineering or five years of directly relevant professional experience.

Students who complete the requirements for the professional certificate and meet the admission requirements can apply for admission as a degree-seeking student in the graduate degree program in packaging of electronics and optical devices.

For those students accepted into the graduate degree program, the courses taken to complete the professional certificate will count toward the graduate degree requirements.

Completion Requirements

The professional certificate will be awarded upon completion of three of the four core courses with a grade of *B* or better in each of the three courses.

The three courses for the professional certificate must be completed within three years from admission to the program.

Doctor of Philosophy (Major in Mechanical Engineering)

The Ph.D. program is one of the most successful programs in the nation. The majority of our students are supported by their own companies, by faculty research grants or by the department through teaching assistant fellowships. The latter option is specifically tailored to students interested in obtaining a faculty position after graduation.

Admission Requirements

1. Master of Science degree in mechanical engineering or in a closely related discipline from a U.S. college or university accredited by a regional accrediting association or completion of an international degree that is equivalent to a U.S. Master's degree from a college or university of recognized standing.
2. Excellent academic performance in all completed coursework, with a GPA of at least 3.0 on a 4.0 scale.
3. Submission of a complete application, including a statement of purpose, official transcripts for all previous undergraduate and graduate studies, and payment of appropriate application fee.
4. Official GRE graduate school entry exam quantitative score of 650 or greater.
5. Three letters of recommendation from individuals who can judge the applicant's potential success as a doctoral student.
6. Graduates from foreign countries are required to submit a notarized financial certification form. All international students whose native language is not English and who have not graduated from an American university must submit a minimum TOEFL English language proficiency score before being considered for admission as follows:
   - 550 – paper-based examination.
   - 213 – computer-based examination.
   - 59 – Internet-based examination.

Degree Requirements

In addition to meeting the Lyle School of Engineering requirements for the Doctor of Philosophy degree, candidates are required to satisfy the following:

The basic requirements of the program are: 1) the successful completion of eight graduate level courses (24 term credit hours) beyond the Master's degree, 2) the successful completion of a qualifying exam that includes both an oral examination on fundamental topics identified by the supervisory committee and the presentation

of a proposal for the dissertation topic, and 3) the completion and successful defense of a dissertation. The dissertation must be original and of a scholarly level and must have the potential of being published in a leading technical journal in the field of interest.

Department Facilities

The mission of our laboratories is to support high-quality practical research and technological innovations.

Computational Graphics, Analysis and Design Laboratory. These dedicated computational facilities include PCs and high-resolution color X-terminals tied to a local area network that allows high-speed communication with the school and University's computers, as well as with off-campus systems via NSFNet. Available software includes Parametric Technologies ProEngineer CAD and Pro/Mechanica MCAE Systems, Ansys finite element analysis package, Micro-Flow and Fluent CFD packages.

Experimental Fluid Mechanics Laboratory. This laboratory supports experimental study of a wide range of fluid flows. Equipment includes a 239-gallon glass water tank, a 524-gallon glass-walled towing tank, a high resolution digital particle image velocimetry system, a 2W Ar+ laser for planar laser induced fluorescence flow visualization and other measurement equipment for investigation of unsteady and complex fluid flows.

High-Power Laser Processing Laboratory. This laboratory provides first-hand experience in the application of high-energy light (focused laser) to process different types of materials, including forming, cutting, drilling, joining, coating and material property modification. The laboratory is equipped with a high-power MultiWave Nd:YAG laser with a power of 1 kW in CW mode and 2.5 kW in modulated mode, a fiber laser of 4 kW in power, a direct diode laser of 2kW in power and a fiber coupled diode laser of 1 kW in power, a three-axis CNC positioning system, three six-axis robots, and a powerful data acquisition system for control and diagnostics.

Information Technology Laboratory. This laboratory gives students a broad overview of information technology and portable computer skills to take to the workplace. This course meets SMU's IT requirement for all SMU students.

Laser Micromachining Laboratory. This laboratory is equipped with lasers and photonics equipment for the fabrication of microscale devices and for time-resolved studies of ultrashort laser-material interactions.

Mechanics of Materials and Structure and Materials Laboratories. This laboratory is equipped for instruction and research on the mechanical behavior of materials under various loading conditions such as tension, compression and flexure as well as impact, hardness and creep. The laboratory features an Instron universal material testing system with various loading fixtures for tension-shearing and bending-stretching tests, mini- and micro-tensile testers, a micro-hardness indenter, a thermal loading chamber, a Keyance digital optical microscope and various other digital imaging units for whole-field deformation measurement applications by digital image correlation analysis.

Opto-Electronic Packaging Laboratory. This laboratory is dedicated to packaging of microelectronics and optical components and systems.

Porous Media Laboratory. This laboratory is devoted to the design, analysis and testing of porous media based systems and devices, including next generation cooling devices, filters, chemical reactors and mixers. The laboratory is equipped

with instrumentation necessary for measuring effective thermo-hydraulic properties, including effective conductivity, permeability and inertia coefficient.

Solid Freeform Fabrication Laboratory. The field of rapid prototyping by solid freeform fabrication is a relatively recent by-product of the computer-integrated manufacturing revolution. SFF processes are additive in nature, in that three-dimensional, CAD geometry is fabricated by successively layering or adding two-dimensional slices of the solid. In this laboratory, high-power laser and welding processes are used to make structurally sound metallic functional parts, molds and dies. The laboratory is equipped with a laser-based cladding system, a micro-plasma powder cladding system and a welding-based deposition system. The deposition stations are incorporated with a five-axis CNC machining center and with a three-axis CNC machining center. The laboratory is equipped with the 3D ZCorp printer and a portable coordinate measuring arm for reverse engineering.

Systems, Measurement and Control Laboratories. These laboratories are equipped for instruction in the design and analysis of analog and digital instrumentation and control systems. Modern measurement and instrumentation equipment is used for experimental control engineering, system identification, harmonic analysis, simulation and real-time control applications. Equipment also exists for microprocessor interfacing for control and instrumentation and for computational and experimental research in biomechanics, dynamics and control.

Submicron Electro-Thermal Sciences Laboratory. This laboratory is dedicated to the experimental research and computational modeling of submicron integrated circuits. The laboratory features a laser-based thermo-reflectance measurement system, a microwave integrated circuit scalar performance electrical measurement system and an adaptive thermal numerical solution package.

Thermal and Fluids Laboratory. Equipment in this laboratory is used for instruction in experimental heat transfer, thermodynamics and fluid mechanics. Modern equipment is available for conducting experiments on energy conservation, aerodynamics, HVAC systems, convective cooling of electronics and heat exchangers.

Welding Laboratory. The laboratory is equipped with several fully computerized welding cells (for gas tungsten arc welding, gas metal arc welding, plasma arc welding, high power laser welding and friction stir welding) to promote high-quality research and technological innovations in arc and plasma welding.

The Courses (ME)

All on-campus mechanical engineering graduate students are expected to enroll and participate each term in the ME 7090 Graduate Seminar.

7301. Entrepreneurship and Business Development in Manufacturing. This course will give students a perspective on entrepreneurial thought and provide the necessary tools for starting a manufacturing venture. Management is the process of creating value from existing resources; in contrast, entrepreneurship is the art of creating the ideas and identifying and assembling the resources to create value. Students will addresses this art for new ventures inside existing corporations and de novo start-ups in the manufacturing realm. They will learn what personality characteristics are important and effective in each of these settings and where they fit. They will learn the risks and rewards of each approach. They will acquire the tools required to develop a business plan. Course content will enable them to answer the most frequently asked questions about entrepreneurship. Examples, exercises and cases will be drawn from a manufacturing environment.

7302 (EE 7362). Linear Systems Analysis. An introduction to the topics within the domain of modern control theory. Special emphasis on the application of the developed concepts in designing linear systems and casting their responses in prescribed forms. Covers state

representation of linear systems, controllability, observability, minimal representation, linear state variable feedback, observers and quadratic regulator theory. *Prerequisite:* ME 4360 or permission of the instructor.

7303. Organizational Leadership. This is a course in personnel and organizational leadership. Students will learn the scientific structure of organizations and methods used to improve the productivity and quality of life of people working in the organization. They will be introduced to industrial-organizational psychology, as applied to the manufacturing organization. This course will focus on understanding individual behavior and experiences in industrial and organizational settings. Students will be introduced to industrial psychology as it addresses the human resource functions of analyzing jobs and appraising, selecting, placing and training people. The organizational psychology portion of the course addresses the psychology of work, including employee attitudes, behavior, emotions, health, motivation and well-being, as well as the social aspects of the workplace.

7314. Introduction to Microelectromechanical Systems (MEMS) and Devices. The basics of microelectromechanical devices and systems, including microactuators, microsensors and micromotors; principles of operation; micromachining techniques (surface and bulk micromachining); IC-derived microfabrication techniques; and thin lm technologies as they apply to MEMS.

7319. Advanced Mechanical Behavior of Materials. A senior-graduate course that relates mechanical behavior on a macro-and microscopic level to design. Includes macroscopic elasticity and plasticity, viscoelasticity, yielding, yield surfaces, work hardening, geometric dislocation theory, creep and temperature-dependent and environment-dependent mechanical properties. *Prerequisites:* ME 2340 and ME 3340, or permission of the instructor.

7320. Intermediate Dynamics. Kinematics and dynamics of particles and rigid bodies: kinematics and inertia properties. Kane's dynamical equations. Euler's equations of motion. D'Alembert's principle and Lagrange's equations of motion. *Prerequisite:* ME 2320 or permission of the instructor.

7321. Failure Analysis. A senior-graduate course in the evaluation of the failure of structural materials and components. Includes site examination, macroscopic examination, optical microscopy, transmission electron and SEM interpretation, examination and interpretation of failure surfaces, failure modes and causes of failure. *Prerequisites:* ME 3340 or permission of instructor.

7322. Vibrations. Fundamentals of vibrations with application of simple machine and structural members. Harmonic motion, free and forced vibration, resonance, damping, isolation and transmissibility. Single, multiple and infinite degree-of-freedom systems. *Prerequisites:* ME 2320 and MATH 2343, or permission of the instructor.

7323. Introduction to Fracture Mechanics. Linear elastic fracture mechanics, application of theory to design and evaluation of critical components: elastic stress intensity calculations, plane strain fracture toughness, plane stress and transitional behavior, crack opening displacements, fracture resistance, fatigue crack propagation, transition temperature approach to fracture control, microstructure of fracture and fracture control programs. *Prerequisite:* ME 2340 or permission of instructor.

7324. Fatigue Theory and Design. A senior-graduate course. Includes continuum, statistical and fracture mechanics treatments of fatigue, stress concentrators, planning and analysis of probit, SNP and response tests, mechanisms of fatigue design, fail safe vs. safe life design and crack propagation. Emphasizes engineering design aspects of fatigue rather than theoretical mechanisms. *Prerequisite:* ME 3340 or permission of instructor.

7326. Vehicle Dynamics. Modeling of wheeled vehicles to predict performance, handling and ride. Effects of vehicle center of mass, tire-characteristic traction and slip, engine characteristics and gear ratios of performance. Suspension design, steady-state handling models of four-wheeled vehicles and car-trailer systems to determine over-steer and understeer characteristics, critical speeds and stability. Multi-degree-of-freedom ride models, including tire and suspension compliance. Computer animation and simulations. *Prerequisite:* ME 2320 or permission of instructor.

7330. Heat Transfer. Application of the principles of conduction, convection and radiation heat transfer. Includes steady- and unsteady-state, special configurations, and numerical and analytical solutions and design. *Prerequisite:* ME 3332 or permission of instructor.

7331. Advanced Thermodynamics. Laws of thermodynamics, availability, irreversibility, real gases and mixtures, thermodynamic relations and generalized charts, combustion, chemical and phase equilibrium and computational combustion. *Prerequisites:* ME 2331 and ME 3341, or permission of instructor.

7332. Heat Transfer in Biomedical Sciences. Fundamentals of heat transfer in medicine and biology. Biothermal properties. Thermal regulation processes. Biomedical heat transfer processes with applications in tissue laser radiation, freezing and thawing of biological materials, cryosurgery and others. *Prerequisite:* ME 3332 or permission of instructor.

7333. Transport Phenomena in Porous Media. Fractals and their role in characterizing complex structures. Fundamental concepts of momentum, heat and mass transport through heterogeneous (e.g., composites, porous) materials. Emphasis on the mathematical modeling of heat and mass transfer in heterogeneous and fully saturated systems. Relevant industrial and natural applications are presented throughout the course. *Prerequisites:* ME 2342 and ME 3332, or permission of instructor.

7334. Fundamentals of Electronic Packaging. An introduction to micro-systems packaging, role of packaging in microelectronics, role of packaging in micro-systems, electrical package design, design for reliability, thermal management, and single- and multichip packaging. IC assembly, passive devices, optoelectronics, RF packaging, MEMS, sealing and encapsulation, system-level printed wiring boards, PWB assembly, packaging materials and processes, and micro-system design for reliability.

7335. Convective Cooling of Electronics. A review the fundamentals of convection heat transfer, followed by applications of these principles to the convective cooling of electronic components and systems. Emphasizes special topics, such as heat sink design, fan and pump selection, augmentation of convection using extended surfaces, spray/jet-impingement cooling and heat pipes. Examines the design of electronic chassis with flow through coldwalls and edge-cooled PWBs.

7336. Intermediate Fluid Dynamics. Review of fundamental concepts of undergraduate fluid mechanics and an introduction to advanced fluid dynamics, industrial irrotational flow, tensor notation and the Navier-Stokes equations. *Prerequisite:* ME 2342 or permission of instructor.

7337. Introduction to Computational Fluid Dynamics: Fundamentals of Finite Difference Methods. Concepts of stability, convergence, accuracy and consistency. Applications to linear and nonlinear model partial differential equations. Curvilinear grid generation. Advanced topics in grid generation. Beam and warming factored implicit technique. MacCormack techniques. Solution methods for the Reynolds equation of lubrication, the boundary layer equations and the Navier-Stokes equations. *Prerequisites:* ME 2342 and MATH 2343, or permission of the instructor.

7340. Introduction to Solid Mechanics. The theories of failure, principal stress and strain for solid bodies. An introduction to plate theory, elastic stability, energy methods and theory of elasticity. Torsional analysis of noncircular sections. *Prerequisite:* ME 2340 or permission of instructor.

7341. Structural Properties of Solids. Designed to develop an understanding of the structural aspects of solids and their relationship to properties and applications. Topics include structural defects, bonding and crystal structure, solid-state reactions and phase transformations, degradation and deformation. *Prerequisite:* ME 3340 or permission of the instructor.

7342. Introduction to Thermal Management of Electronics. This course will emphasize the thermal design of electronic packages and systems. Topics covered will include the basics of conduction, convection (natural and forced) and radiation heat transfer. In addition, the following topics will also be covered: pool boiling and flow boiling, extended surfaces as applied to the design of heat exchangers and cold plates, and thermal interface resistance as applied to the design of electronic packages. Modern cooling technologies, such as single-

phase cooling and two-phase cooling, heat pipes and thermoelectric coolers, will be introduced.

7343. Electronic Packaging Materials: Processes, Properties and Testing. An overview of materials for electronic packaging. Examines solderability, microscopic processes and alloy selection. Looks at composites and ways to apply conducting polymer-matrix composites, metal films and vacuum processes. Covers the importance of encapsulation, temperature humidity bias testing and temperature cycle testing. Also, measurement of properties of material in electronic packaging, thermal properties, physical properties, and manufacturing properties and materials selection.

7344. Conductive Cooling of Electronics. Reviews the fundamental concepts of conduction heat transfer, followed by applications of these principles to the conductive cooling of electronic components and systems. Emphasizes special topics, such as contact conductance, interface thermal resistance, heat spreaders, thermal interface materials, phase change materials and thermoelectric devices. Covers cooling of special electronic components, such as multichip modules, power modules, high density power supplies and printed wiring boards.

7346. Application of Computational Techniques to the Mechanical and Thermal Design of Electronic Systems. Characterizes the mechanical and thermal performance of electronic devices and systems through the use of computational techniques. Commercial codes will be used to create thermal models of systems and the design of cold plates and heat exchangers. Covers the concepts of structural modeling of components mounted on printed wiring boards in a vibration environment.

7348. Thermal, Fluid and Mechanical Measurements in Electronics. Thermal and fluid measurement topics, including need for experimentation in electronic design, use of similitude in electronics cooling, velocity, temperature and pressure measurements, thermal conductivity and thermal diffusivity measurements, heat flux measurements, flow visualization techniques and characterization of electronic components. Also covers experimental procedures used for vibration and shock testing of electronic equipment.

7350. Design for Manufacturability and Concurrent Engineering. Examines the advantages of involving both manufacturing and engineering in the early design of products and processes. Includes technical guidelines for using manufacturing processes effectively and cost determination and assessment of processing alternatives at the early design/manufacturing interface. Examines design/designing for manufacturing processing and factory capabilities as a function of quality, price performance and productivity, with emphasis on parts and process simplification, alternative methods, anticipated volumes and automated assembly.

7351. Computer Integrated Manufacturing Systems. Basic concepts and use of computer-integrated manufacturing. Includes integration approaches for manufacturing; process planning and simulation; the production process in relation to automated control systems; process design; shop floor control of multiple interacting processes; distributed network process control; real-time aspects; interface protocols and languages of production processes; computational and data processing methods for planning, design, production and shipping and methods of optimizing output quality, price and productivity. Examines economic justification and the use of artificial intelligence for planning and process control.

7352. Manufacturing Methods and Systems. This course is intended as an overview course for the M.S. degree in manufacturing systems management. Highly successful manufacturing methods and systems will be examined. Topics include the evolution of manufacturing technology in the United States, mass manufacturing, integrated manufacturing, distribution and manufacturing automation, just-in-time systems, continuous improvement, Kaizen, poka yoke, and total quality management. Modern Japanese manufacturing techniques will be examined in depth. The underlying concepts and strategic benefits of flexibility, agility, time-based competition, and global manufacturing operations will be covered. The course will be presented from the perspective of the manufacturing manager.

7353. Manufacturing Management. This course will explore new organizational structures, paradigms and leadership styles. Problem solving within the business context: manufacturing strategies for optimizing production processes across the enterprise. Measuring and reporting

business performance; investment decision-making under conditions of risk and uncertainty; intellectual property strategies, products liability and the legal environment; contemporary practices, including self-directed work forces, competitive assessment, total productive maintenance, managerial and activity-based costing.

7354. Lean Manufacturing and Six Sigma. The focus of this course is an overall total quality management perspective for the design of quality management systems. Metrics for cycle time and defects, base-lining and benchmarking and House of Quality approaches are examined. Also covered is the basic concept of managing product quality from inception to deployment. Topics include acquiring and stabilizing new production processes, data collection and analysis for improvement and decision-making. Purchasing, process control and reliability are covered in detail. Taguchi and poka yoke and other practices as tools for implementing total quality management.

7358. Vibration Analysis of Electronic Systems. This course will introduce the problems encountered in the mechanical design of electronics, particularly in the area of vibrations. Topics covered will include: vibrations of simple electronic systems, component lead wire and solder joint vibration fatigue life, beam structures for electronic subassemblies, printed wiring boards and flat plates, snubbing and damping to increase PWB fatigue life, prevention of sinusoidal vibration environments, design of electronic boxes, effects of manufacturing methods on reliability of electronics and vibration testing. *Prerequisites:* ME 2320 and MATH 2343.

7359. Analysis and Design of Optoelectronic Packaging. An overview of optical fiber interconnections in telephone networks, packaging for high-density optical back planes and selection of fiber technologies; semiconductor laser and optical amplifier packaging, optical characteristics and requirements, electrical properties, mechanical properties, waveguide technologies, optical alignment and packaging approaches, passive device fabrication and packaging and array device packaging; hybrid technology for optoelectronic packaging and flip-chip assembly for smart pixel arrays.

7360. Electronic Product Design and Reliability. Investigates the failures, failure modes and failure mechanisms in electronic systems. Covers failure detection, electrical simulation and environmental stress tests. Also, failure analysis, including the use of X-rays, thermal imaging/infrared microscopy, acoustical imaging, scanning laser acoustic microscopy, infrared spectroscopy, differential scanning calorimeter, thermo-mechanical analyzer and other testing procedures. In addition, solder joint reliability of balls grid array assemblies, plastic ball grid array assemblies, flip-chip assemblies, chip-scale package (CSP) assemblies and fine pitch, surface mount technology assemblies. Temperature as a reliability factor, an overview of high temperature electronics, the use of silicon devices at high temperatures and selection of passive devices for use at high temperatures.

7361. Matrix Structural Analysis. A systematic approach to formulation of force and displacement method of analysis, representation of structures as assemblages of elements and computer solution of structural systems. *Prerequisite:* Permission of instructor.

7362. Engineering Analysis With Numerical Methods. Applications of numerical and approximate methods in solving a variety of engineering problems. Include equilibrium, buckling, vibration, fluid mechanics, thermal science and other engineering applications. *Prerequisite:* Permission of the instructor.

7363. Electronic Manufacturing Technology. Covers the complete field of electronics manufacturing. Includes an introduction to the electronics industry, electronic components, the theory and methods of manufacture of solid state devices, packaging techniques such as wire bonding flip chip and TAB, printed wiring board, soldering and solderability, leaded and surface mounted components, electromagnetic interference, electrostatic discharge prevention, testability and electronic stress screening. Discusses, in each area, the current technology as well as leading edge tools.

7364. Introduction to Structural Dynamics. Dynamic responses of structures and behavior of structural components to dynamic loads and foundation excitations, single- and multi-degree-of-freedom systems response and applications to analysis of framed structures and introduction to systems with distributed mass and flexibility. *Prerequisites:* ME 8361 and MATH 2343, or permission of instructor.

7365. Strategies for Manufacturing. The development and implementation of strategies for product design and manufacturing that best support the overall strategy of the firm. Includes positioning the product and production system in the industry, location and capacity decision, implementing manufacturing technologies, facilities planning, vertical integration, logistics planning and organizational culture. Uses case studies of manufacturing firms extensively.

7366. Global Manufacturing. Goals and strategies for manufacturing operations in the multinational environment. Includes decision making for decentralizing and setting up foreign manufacturing operations; marketing, sales and distribution strategies; R&D support; location and capacity decisions; implementing new manufacturing technologies; facilities planning and modernizations; vertical integration; outsourcing strategies; logistics planning and organizational cultures. Uses case studies of manufacturing firms.

7369. Innovation Management. This course provides a foundation of modern theory and practice of product innovation in three parts. First, the course will review the macro-theory of disruptive innovation: technological, organizational, and market-driven. Second, the course covers how to implement and augment fast innovation capability within an organization. Third, the project-level innovation/invention will be covered, with such methods as quality function deployment, morphological analysis and the theory of inventive problem solving. The students will practice methods through the use of case studies and explore and develop disruptive innovation in a class project.

7371. Gas Dynamics and Design of Propulsion Systems. One-dimensional compressible flow, linearized two-dimensional flow method of characteristics and oblique shocks. Design of air-breathing propulsion systems components: inlets, nozzles, compressors, turbines and combustors. Interactions with the external flow. *Prerequisites:* ME 2342 and ME 3341 or permission of instructor.

7372. Introduction to CAD/CAM. Introduction to mechanical computer-aided design (CAD). Survey of technical topics related to CAD and computer-aided manufacturing (CAM). Emphasis on the use of interactive computer graphics in modeling, drafting, assembly and analysis. Extensive hands-on use of Pro/Engineer, a state-of-the-art CAD system. *Prerequisite:* Graduate standing.

7376. Robotics: Introduction to Computer-Aided Manufacturing (CAM). Introduction to industrial robotics and numerically controlled machines. Economics of CAM. Applications of robotics in industry. Robot safety. Addition of senses and intelligence. Research in CAM. Flexible manufacturing cells and systems. Hands-on laboratory work with industrial robots and NC machines. Independent study and report on a specific robot application. *Prerequisites:* PHYS 1301, MATH 2343 and CSE 1341 or permission of instructor.

7382. Finance and the Manufacturing Enterprise. An overview of strategic management decision processes relevant to engineering, manufacturing and service industries. The targeted student is the current or future professional engineer-manager, engineer-owner and/or engineer-entrepreneur who combine engineering/manufacturing technology with business execution. Emphasis on how engineering and manufacturing managerial functions interact with the finance industry, markets and institutions.

7383. Heating, Ventilating and Air Conditioning. Selection and design of basic refrigeration, air conditioning and heating systems. Includes load calculations, psychometrics, cooling coils, cooling towers, cryogenics, solar energy applications and special topics. *Prerequisites:* ME 2331 and ME 3332, or permission of instructor.

7386. Convection Heat Transfer. Advanced topics in forced convection heat transfer using analytical methods and boundary-layer analysis. Laminar and turbulent flow inside smooth tubes and over external surfaces. Convection processes in high-speed flows. *Prerequisite:* ME 3332 or permission of the instructor.

7090. Graduate Seminar. Lectures by invited speakers from industry and academia and SMU faculty and students on research topics of current interest in civil engineering, mechanical engineering and engineering mechanics. All students, staff and faculty are invited.

7190. Seminar Series on Ethics in Engineering and Technology. A one-hour course that covers ethical issues, hard choices and human failures in life. Discusses practical, ethical issues with examples from everyday life. Includes ethical issues encountered in copyright law and intellectual property, along with issues involved in telephone communications and e-mail. Discusses principles, methods and bases for ethical decision-making and action.

8338. Viscous Flow Theory. A study of the motion of viscous fluids, low Reynolds number and laminar boundary-layer theory for a Newtonian fluid and exact and approximate methods for solution of problems. *Prerequisite:* ME 2342 or permission of the instructor. Corequisite: MATH 6333 or permission of the instructor.

8339. Turbulent Shear Flow. A study of real turbulent flows; flow stability, transition and turbulence structure; free shear, pipe and boundary layer flows; effects of surface conditions, blowing and suction, pressure gradients and compressibility; approximate solution methods and atmosphere shear flows. *Prerequisite:* ME 8338 or permission of instructor.

8340. Theory of Elasticity. The study of stress, strain and stress-strain relationships for elastic bodies. Classical solutions of two- and three-dimensional problems. The use of the Airy stress function. *Prerequisite:* ME 7340 or permission of instructor.

8342. Theory of Plasticity. Physical basis of plastic deformation and mathematical theory of yield and plastic flow with applications to various engineering problems. *Prerequisite:* Permission of the instructor.

8344. Energy Methods in Applied Mechanics. Discusses the variational energy principles of mechanics and applies them to analysis of beams and trusses, general elasticity problems, plates and shells, buckling and dynamics. *Prerequisite:* ME 7340 or permission of the instructor.

8346. Mechanics of Composite Materials. Introduction to analysis of composite material behavior, including stiffness and strength relations for a lamina and for laminates and the effect of lamination on deflection, buckling and vibration of plates. *Prerequisite:* ME 7340 or permission of the instructor.

8361 (EE 8361). Multivariable Control System Design. Introduction to multivariable systems. State determined control systems. Polynomial algebras and matrices. Traditional fraction representation. Feedback, sensitivity and stabilization. Sensitivity integrals. Introduction to H∞, μ and QFT control design. Interaction indices and H-matrices. Design examples. *Prerequisite:* ME 4360 or permission of instructor.

8364. Finite Element Methods in Structural and Continuum Mechanics. Theory and application of finite element, two- and three-dimensional elements, bending elements, applications to buckling and dynamic problems. *Prerequisite:* ME 7361 or permission of the instructor.

8366. Basic Concepts of Structural Stability. Unified approach to elastic buckling analysis of columns, plates and shells using variational calculus (developed entirely in the course). *Prerequisite:* ME 7340 or permission of instructor.

8367 (EE 8367). Nonlinear Control. An introduction to methods of the control of nonlinear systems. Reviews phase plane analysis of nonlinear systems, Lyapunov theory, nonlinear stability and describing function analysis. Advance control techniques, including feedback linearization, sliding control and adaptive control. Special emphasis on the application of the developed concepts to the robust regulation of the response of nonlinear systems. *Prerequisite:* ME 7302/EE 7362 or permission of the instructor.

8368. Theory of Plate Behavior. Analysis of flat plates subjected to normal loading, inplane loading and thermal stresses. Analyzes plates of various shapes, thick plates and anisotropic plates for both small and large deflections. *Prerequisite:* ME 7340 or permission of instructor.

8369. Theory of Shell Behavior. Membrane and bending theories of cylindrical shells, shells of revolution and translational shells and their application to various problems in aerospace, manufacturing and construction industries. *Prerequisite:* ME 7340 or permission of instructor.

8385. Conduction Heat Transfer. Analytical and numerical methods as applied to several cases of steady- and unsteady-state conduction. Includes temperature dependent properties, multidimensional system and heat sources.

8387. Radiation Heat Transfer. Basic laws and definitions of thermal radiation. Radiation properties of surfaces. Basic equations for energy transfer in absorbing, emitting and scattering media. Applications to combined conduction-radiation and convection-radiation problems. *Prerequisite:* ME 3332 or permission of the instructor.

Advanced Special Topics

7(0,1,2,3,6)96. Master's Thesis. Variable credit, but no more than six term hours in a single term and not more than four in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, four term hours of thesis would require enrollment in ME 7396 and ME 7196.

7(1–4)9(4–5). Selected Problems. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the instructor (on request).

7384. Advanced Topics II. Advanced selected topics in mechanical engineering and its application (on request).

7(1–9)9(0–3). Selected Topics. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

8(0,1,6,9)96. Dissertation. Variable credit, but no more than 15 term hours in a single term and not more than 10 term hours in a summer terms. Enrollment in several sections may be needed to obtain the desired number of dissertation hours. For example, 12 term hours of dissertation would require enrollment in ME 8390 and ME 8990.

8(1–9)9(0–4). Selected Topics. Individual or group study of selected topics in mechanical engineering approved by the department chair and the instructor (on request).

Special Courses

Courses reflecting specific areas of interest are listed below. These courses have not been taught on a regular basis and may be offered if sufficient interest is shown.

8325. Random Vibrations. Fundamentals of random vibrations, statistical analysis, frequency response, spectral density, autocorrelation, Fourier methods and applications. *Prerequisite:* ME 7322 or permission of the instructor.

8326. Vibrations of Elastic Bodies. The study of impact and vibrations of continuous, elastic bodies: free and forced vibrations of bars, beams and plates for various boundary conditions. *Prerequisite:* ME 7322 or permission of the instructor.

8327. Wave Propagation in Continuous Media. Review of vibration theory in discrete and continuous media, stress waves in solids, transmission phenomena and pressure waves in fluids. *Prerequisites:* ME 7322 and MATH 2343, or permission of the instructor.

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