Lyle School of Engineering

Graduate Programs

Southern Methodist University

2014–2015

NOTICE OF NONDISCRIMINATION

Southern Methodist University will not discriminate in any employment practice, educational program or educational activity on the basis of race, color, religion, national origin, sex, age, disability, genetic information or veteran status. SMU's commitment to equal opportunity includes nondiscrimination on the basis of sexual orientation and gender identity and expression. The Office of Institutional Access and Equity has been designated to handle inquiries regarding the nondiscrimination policies and may be contacted at Southern Methodist University, Dallas TX 75275; phone: 214-768-3601; email: accessequity@smu.edu.

BULLETIN OF SOUTHERN METHODIST UNIVERSITY

VOL. XCII 2014–2015

Southern Methodist University publishes a complete bulletin every two years. The undergraduate catalog and the Cox, Dedman Law and Simmons graduate catalogs are updated annually. The Dedman College, Hart eCenter Lyle, Meadows and Perkins graduate catalogs are updated biennially. The following catalogs constitute the General Bulletin of the University:

Undergraduate Catalog
Cox School of Business Graduate Catalog
Dedman College of Humanities and Sciences Graduate Catalog
Dedman School of Law Graduate Catalog
Hart eCenter Graduate Catalog
Lyle School of Engineering Graduate Catalog
Meadows School of the Arts Graduate Catalog
Perkins School of Theology Graduate Catalog
Simmons School of Education and Human Development Graduate Catalog

In addition, certain locations or programs provide their own schedules:

Continuing Education	SMU-in-Plano
J Term and May Term	SMU-in-Taos (Fort Burgwin)
SMU Abroad	Summer Studies

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.

Catalog addenda are published online at www.smu.edu/catalogs. An addendum includes graduation, degree and transfer requirements that do not appear in a specific print or online catalog but apply in that academic year.

Additional information can be obtained by writing to the Undergraduate Office of Admission or to the appropriate school (listed above) at the following address:

Southern Methodist University
Dallas TX 75275

Information also is available at www.smu.edu.

Produced by the Office of the Provost
Southern Methodist University
Dallas TX 75275-0221
2014

CONTENTS

ACADEMIC YEAR 2014–2015

www.smu.edu/registrar/academic_calendar.asp

This calendar includes a list of religious holidays for use in requesting excused absences according to University Policy 1.9. For religious holidays not listed, students should contact the Office of the Chaplain. Graduate programs in the Cox School of Business, the Perkins School of Theology, the Dedman School of Law and the Department of Dispute Resolution and Counseling within the Simmons School of Education and Human Development have different calendars.

Fall Term 2014

April 7–25, Monday–Friday: Enrollment for fall 2014 continuing students for all undergraduates and for graduates in Dedman College, Lyle and Meadows.

May, July, August – TBA: Academic Advising, Enrollment and Orientation conferences for new first-year and transfer undergraduate students. Additional information about AARO is available from New Student Programs, Student Life Office, 214-768-4560, www.smu.edu/newstudent.

August 20, Wednesday: Residence halls officially open for students attending Mustang Corral.

August 22, Friday: Residence halls officially open for all other students.

August 24, Sunday: Opening Convocation, Moody Coliseum.

August 25, Monday: First day of classes.

August 29, Friday: Last day to enroll, add courses or drop courses without a grade record. Also, last day to file for graduation in December.

September 1, Monday: Labor Day. University closed.

September 10, Wednesday: Last day to declare pass/fail, no credit or first-year repeated course-grading options. Also, last day to request an excused absence for the observance of a religious holiday.

September 29, Monday: Early intervention grades due for first-year undergraduate students.

October 13–14, Monday–Tuesday: Fall break.

October 24–25, Friday–Saturday: Family Weekend.

October 26, Sunday: Midterm grades due for first-year and sophomore students.

October 27, Monday: Last day for continuing undergraduate students to change their majors before November enrollment.

November 3, Monday: 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 3–21, Monday–Friday: Enrollment for spring 2015 continuing students for all undergraduates and for graduates in Dedman College, Lyle and Meadows.

November 7, Friday: Last day to drop a course.

Fall Term 2014 (continued)

November 13, Thursday: Last day for December graduation candidates to change grades of Incomplete.

November 14–15, Friday–Saturday: Homecoming Weekend.

November 21, Friday: Students should file for May graduation. The last day to file is January 25, 2015.

November 25, Tuesday: Last day to withdraw from the University.

November 26, Wednesday: No classes.

November 27–28, Thursday–Friday: Thanksgiving holiday. University closed.

December 3–8, Wednesday–Monday: No final examinations or unscheduled tests/papers.

December 4, Thursday: Last day for oral/written examinations for December graduate degree candidates.

December 8, Monday: Last day of classes.

December 9–10, Tuesday–Wednesday: Reading days.

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

December 18, Thursday: Residence halls close at 10 a.m. for winter break. (December graduates and residential students who need winter break housing should contact the Department of Residence Life and Student Housing.)

December 20, Saturday: Official close of the term and date for conferral of degrees. Also, graduation ceremony for December graduates.

December 24–January 1, Wednesday–Thursday: University closed.

December 25, Thursday: Christmas Day.

January Interterm 2015

Note: Some areas of instruction offer selected courses during the January interterm, December 18, 2014–January 14, 2015.

January 1, Thursday: New Year's Day. University closed.

J Term at SMU-in-Plano

January 5, Monday: First day of classes.

January 6, Tuesday: Last day to declare pass/fail.

January 13, Tuesday: Last day to drop a course or withdraw from the University.

January 14, Wednesday: Last day of classes, including examinations.

J Term at SMU-in-Taos

Note: The following dates are applicable only for SMU-in-Taos. Permission of the SMU-in-Taos program is required for all enrollments.

January 2, Friday: Wellness student travel and arrival.

January 4, Sunday: Regular session travel and arrival.

January 5, Monday: First day of classes.

January 14, Wednesday: Last day of classes, including examinations.

January 15, Thursday: Departure of students.

Spring Term 2015

November 3–January 23, Monday–Friday: Enrollment for spring 2015 continuing students for all undergraduates and graduates in Dedman College, Lyle and Meadows.

January – TBA: Academic Advising, Enrollment and Orientation conferences for new first-year and transfer undergraduate students. Additional information about AARO is available from New Student Programs, Student Life Office, www.smu.edu/newstudent, 214-768-4560.

January 1, Thursday: New Year's Day. University closed.

January 13, Tuesday: Residence halls officially open at 9 a.m.

January 16, Friday: First day of classes.

January 19, Monday: Birthday of Martin Luther King, Jr. University closed.

January 23, Friday: Last day to enroll, add courses or drop courses without a grade record. Also, last day to file for May graduation.

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

February 22, Sunday: Early intervention grades due for first-year undergraduate students.

March 9–15, Monday–Sunday: Spring break.

March 24, Tuesday: Midterm grades due for first-year and sophomore students.

March 31, Tuesday: 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 3, Friday: Good Friday. University closed.

April 5, Sunday: Easter Sunday.

March 30, Monday: Last day for continuing undergraduate students to change their majors before April enrollment.

April 6–24, Monday–Friday: Enrollment for summer 2015 and fall 2015 continuing students for all undergraduates and for graduates in Dedman College, Lyle and Meadows.

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

April 10, Friday: Last day for May graduation candidates to change grades of Incomplete.

April 13, Monday: Honors Convocation, 5:30 p.m.

April 16, Thursday: Students should file for August or December graduation. Last day to file for August graduation is June 4. Last day to file for December graduation is the last day to enroll for fall 2015.

April 24, Friday: Last day to withdraw from the University.

April 29–May 4, Wednesday–Monday: No final examinations or unscheduled tests or papers.

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

May 4, Monday: Last day of classes.

May 5, Tuesday: Reading day.

May 6–12, Wednesday–Tuesday: Examinations. (No examinations scheduled for Sunday.)

May 13, Wednesday: Residence halls officially close for nongraduating students.

May 15, Friday: Baccalaureate.

May 16, Saturday: Commencement.

May 17, Sunday: Residence halls officially close for graduating seniors.

May Interterm 2015

Note: Some areas of instruction may offer a limited number of selected courses during the May term, May 13–30. Each May term course may have unique start and end dates within the May 13–30 term to accommodate the particular needs of the course.

May Term at SMU in Dallas 2015

Classes meet 4 hours a day, Monday–Friday.

May 14, Thursday: First day of classes.

May 15, Friday: Last day to enroll or add courses. Also, last day to declare pass/fail, no credit or first-year repeated course-grading options.

May 25, Monday: Memorial Day. University closed.

May 26, Tuesday: Last day to drop a course or withdraw from the University.

May 29, Friday: Last day of classes, including examinations.

June 4, Thursday: Last day to file for August graduation.

Note: Students planning to complete their degree requirements during the May term should complete an Application for Candidacy to Graduate (via the Student Center) for August degree conferral. Specific information is available from the student's academic degree counselor.

May Term at SMU-in-Taos 2015

Note: The following dates are applicable only for SMU-in-Taos. Permission of the SMU-in-Taos program is required for all enrollments.

May 13, Wednesday: Travel day and arrival of students, 2–6 p.m.

May 14, Thursday: First day of classes.

May 29, Friday: Examinations.

May 30, Saturday: Departure of students.

Summer Term 2015

The summer term consists of three primary sessions: first session, second session and a full summer session. Each primary session has different deadline dates. There are also shorter and longer sessions to accommodate the particular needs of the various instructional units such as SMU Abroad, SMU-in-Taos and the Perkins School of Theology.

Full Summer Session

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

May 25, Monday: Memorial Day. University closed.

June 1, Monday: First day of classes.

June 4, Thursday: Last day to enroll, add courses or drop courses without a grade record. Also, last day to file for August graduation.

June 10, Wednesday: Last day to declare pass/fail, no credit or first-year repeated course-grading options.

July 3, Friday: Independence Day holiday. University closed.

July 4, Saturday: Independence Day.

July 16, Thursday: Last day for August graduation candidates to change grades of Incomplete.

July 23, Thursday: Last day to drop a course.

July 29, Wednesday: Last day to withdraw from the University.

August 4, Tuesday: Last day of classes, including examinations. Also, official close of the term and date for conferral of degrees.

First Session

Classes meet 2 hours a day, Monday–Friday.

May 25, Monday: Memorial Day. University closed.

June 1, Monday: First day of classes.

June 2, Tuesday: Last day to enroll, add courses or drop courses without a grade record.

June 4, Thursday: Last day to declare pass/fail, no credit or first-year repeated course-grading options. Also, last day to file for August graduation.

June 23, Tuesday: Last day to drop a course.

June 24, Wednesday: Last day to withdraw from the University.

June 30, Tuesday: Last day of classes, including examinations.

Summer I Session at SMU-in-Taos

Note: The following dates are applicable only for SMU-in-Taos. Permission of the SMU-in-Taos program is required for all enrollments.

June 3, Wednesday: Arrival of students.

June 4, Thursday: First day of classes.

June 5, Friday: Last day to enroll, add courses or drop courses without a grade record. Permission of the SMU-in-Taos program is required for all enrollments.

July 1, Wednesday: Examinations.

July 2, Thursday: Departure of students.

June Term at SMU-in-Taos

Note: Permission of the SMU-in-Taos program is required for all enrollments.

The June term within the Summer I Session at SMU-in-Taos is a short, intense term in which students may take up to four credit hours. Additional information is available online at www.smu.edu/taos.

Second Session

Classes meet 2 hours a day, Monday–Friday.

June 5, Friday: Last day to file for August graduation.

July 3–4, Friday–Saturday: Independence Day holiday. University closed Friday.

July 6, Monday: First day of classes.

July 7, Tuesday: Last day to enroll, add courses or drop courses without a grade record.

July 9, Thursday: Last day to declare pass/fail, no credit or first-year repeated course-grading options.

July 15, Wednesday: Last day for August graduation candidates to change grades of Incomplete.

July 27, Monday: Last day to drop a course.

July 29, Wednesday: Last day to withdraw from the University.

August 4, Tuesday: Last day of classes, including examinations. Also, official close of the term and conferral date.

August Term at SMU-in-Taos

Note: The following dates are applicable only for SMU-in-Taos. Permission of the SMU-in-Taos program is required for all enrollments.

August 4, Tuesday: Travel day and arrival of students, 4–6 p.m.

August 5, Wednesday: First day of classes.

August 6, Thursday: Last day to enroll, add courses or drop courses without a grade record.

August 20, Thursday: Examinations.

August 21, Friday: Departure of students.

Major Religious Holidays

(August 2014–August 2015)

The following list of religious holidays is 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, 2014

Easter Sunday: April 5, 2015

Good Friday: April 3, 2015

Easter Sunday (Orthodox): April 12, 2015

Hindu

Janmashtami: August 17, 2014

Diwali: October 23, 2014

Dasera: October 4, 2014

*Jewish**

Rosh Hashanah: September 24–25, 2014

Hanukkah: December 17–24, 2014

Yom Kippur: October 4, 2014

Pesach (Passover): April 4–11, 2015

Sukkot: October 9–15, 2014

Shavuot: May 24–25, 2015

*Muslim**

Eid al-Adha: October 4, 2014

Mawlid an-Nabi: January 3, 2015

Islamic New Year: October 25, 2014

Ramadan: June 18–July 18, 2015

Ashura: November 5, 2014

Eid al-Fitr: July 18, 2015

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

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 will create, expand and impart knowledge through teaching, research and service, while shaping individuals to contribute to their communities and excel in their professions in an emerging global society. Among its faculty, students and staff, the University will cultivate principled thought, develop intellectual skills and promote an environment emphasizing individual dignity and worth. SMU affirms its historical commitment to academic freedom and open inquiry, to moral and ethical values, 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:

Goal One: To enhance the academic quality and stature of the University.

Goal Two: To improve teaching and learning.

Goal Three: To strengthen scholarly research and creative achievement.

Goal Four: To support and sustain student development and quality of life.

Goal Five: To broaden global perspectives.

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 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, Edwin L. Cox School of Business, Dedman School of Law, Bobby B. Lyle School of Engineering, Meadows School of the Arts, Perkins School of Theology, and Annette Caldwell Simmons School of Education and Human Development.

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.

At its opening session in 1915, the University had two buildings, 706 students, a 35-member faculty and total assets of $633.540.

Today, the University has more than 100 buildings, a total enrollment that has averaged more than 10,000 the past 10 years, a full-time faculty of 727 and assets of $2.5 billion – including an endowment of $1.3 billion (market value, May 31, 2013).

Offering only a handful of degree programs at its 1915 opening, the University presently awards baccalaureate degrees in more than 80 programs through five

undergraduate schools and a wide variety of graduate degrees through those and one professional school.

Of the 10,929 students enrolled for the 2013 fall term, 6,357 were undergraduates and 4,572 were graduate students. The full-time equivalent enrollment was 6,271 for undergraduates and 3,176 for graduate students.

Nearly all the students in SMU's first class came from Dallas County, but now 50 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 more than 100 foreign countries; and from all races, religions and economic levels.

Undergraduate enrollment is 51 percent female. Graduate and professional enrollment is 42 percent female.

A majority of SMU undergraduates receive some form of financial aid. In 2013–2014, 75 percent of first-year students received some form of financial aid, and 35 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 Southern Association of Colleges and Schools Commission on Colleges to award bachelor's, master's, professional and doctoral degrees. Students should 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. Note: The commission is to be contacted only if there is evidence that appears to support an institution's significant noncompliance with a requirement or standard.

Individual academic programs are accredited by the appropriate national professional associations.

In Dedman College, the Department of Chemistry is accredited annually by the Committee on Professional Training of the American Chemical Society, and the Psychology Department's Ph.D. program in clinical psychology is accredited by the American Psychological Association.

The Cox School of Business is accredited by AACSB International, the Association to Advance Collegiate Schools of Business (777 South Harbour Island Boulevard, Suite 750, Tampa, Florida 33602-5730; telephone number 813-769-6500). The Cox School was last reaccredited by AACSB International in 2012.

The Dedman School of Law is accredited by the American Bar Association. The ABA conducted its inspection in 2012, and the Dedman School of Law was reaccredited in 2013.

In the Linda and Mitch Hart eCenter, The Guildhall at SMU's Master of Interactive Technology is accredited by the National Association of Schools of Art and Design for two specializations in art creation and level design.

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, www.abet.org. The undergraduate computer science program that awards the degree Bachelor of Science is accredited by the Computing Accreditation Commission of ABET. The undergraduate computer science program that awards the degree

Bachelor of Arts is not accredited by a Commission of ABET. ABET does not provide accreditation for the discipline of management science.

In the Meadows School of the Arts, the art and art history programs are accredited through the National Association of Schools of Art and Design, the Dance Division is accredited by the National Association of Schools of Dance, the Music Division is accredited by the National Association of Schools of Music, the music therapy program is approved by the American Music Therapy Association, and the theatre program is accredited by the National Association of Schools of Theatre.

Perkins School of Theology is accredited by the Commission on Accrediting of the Association of Theological Schools in the United States and Canada (10 Summit Park Drive, Pittsburgh, Pennsylvania 15275-1110; phone 412-788-6505) to award M.Div., M.A.M., M.S.M., M.T.S. and D.Min. degrees.

Accredited programs in the Simmons School of Education and Human Development include the teacher education undergraduate and graduate certificate programs, which are accredited by the State Board of Educator Certification and the Texas Education Agency. The undergraduate program is approved annually by TEA. The SBEC and the TEA also accredit the M.Ed. in educational leadership's Accelerated School Leadership Program and the M.Ed. in educational leadership with urban specialization. The M.S. in counseling program meets the licensure standards of the Licensed Professional Counselors State Board and the Licensed Marriage and Family Therapist State Board. The Learning Therapist Certificate Program is accredited by the International Multisensory Structured Language Education Council.

SMU LIBRARIES

www.smu.edu/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 four million volumes. The Web-based library catalog system provides access to bibliographic records of materials housed in all SMU libraries and hypertext links to other databases, digitized collections and relevant websites. All SMU libraries offer wireless Internet access.

SMU libraries are one of the greatest assets of the University. SMU libraries rank first in total volumes held among non-Association of Research Libraries universities in the United States. The SMU libraries comprise the largest private research library in Texas and rank third in the state in total volumes, after the University of Texas at Austin and Texas A&M University. The University's library system is divided into a number of different units:

1. Central University Libraries.
2. Underwood Law Library.
3. Bridwell Library.
4. Business Library.

LABORATORIES AND RESEARCH FACILITIES

The University provides laboratories and equipment for courses in accounting, anthropology, art, biology, chemistry, languages, Earth sciences, communication arts, psychology, physics, health and physical education, dance, music, theatre, and statistics, as well as civil, computer, electrical, environmental and mechanical engineering. The University is also home to a number of centers and institutes.

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 in the world, as well as selected masterpieces of modern European sculpture, from Rodin and Maillol to David Smith and Claes Oldenburg. The permanent collection of more than 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 used 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. Additional information is available at www.meadowsmuseumdallas.org.

TUITION, FEES AND LIVING EXPENSES

A catalog supplement, the *Financial Information Bulletin,* 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 can be accessed at www.smu.edu/bursar ("Financial Bulletin" link).

Continuing students registering must ensure that payment for the full amount of charges is posted to their account by the payment due date showing on their bill. The due dates are also published on the Bursar website.

Billing notifications are sent to the student's SMU email address and to the designated authorized payer(s) email address when a bill is generated. The billing notification will provide instructions on how to view the bill online through SMUpay. If notification is not received two weeks prior to the due date, the student and/or designated authorized payer(s) should contact the Office of the University Bursar.

Payments made in person or mailed must be received by the Office of the University Bursar, located on the first floor of the Laura Lee Blanton Student Services Building, no later than 4 p.m. on the payment due date. Payments made online via electronic check or credit card must be posted no later than 11:59 p.m. Central Standard Time on the payment due date. Students and/or those paying on behalf of the student who pay online automatically receive an electronic confirmation of payment; students and/or designated authorized payer(s) paying through other methods can also verify receipt of payment online.

Students enrolling after the payment due date must pay at the time of enrollment. Students whose accounts are not cleared by the payment due date or at the time of enrollment are subject to a late payment fee of $50 for balances between $250 and $999.99, and $150 for balances between $1,000 and $5,000. Balances more than $5,000 are charged 3 percent of the outstanding balance, not to exceed $750. Also, after the monthly payment due date has passed, a 1.5 percent past due fee will be assessed on the unpaid student and/or miscellaneous account each month until the balance is paid. The enrollment of students whose accounts remain unpaid after the payment due date may be canceled at the discretion of the University. Students are individually responsible for their financial obligations to the University.

All refunds except federal parent PLUS loans, prepayment accounts, the SMU Monthly TuitionPay Payment Plan and international wires will be made payable to the student. International wires will be refunded by wire to the originating wire account less a $35 wire-processing fee. The PLUS loan borrower can request the refund to be processed to the student by submitting a Parent PLUS Release form, located on the Bursar website. 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. Any outstanding debts to the University that include Title IV funds must have an Authorization to Credit Account form and/or an Authorization to Credit Account Parent form on file in order to transfer funds to cover current award year debts. Students need to sign the ACA form and the federal parent PLUS loan borrower needs to sign the ACAP form.

Any outstanding debts to the University that do not include Title IV funds will be deducted from the credit balance prior to issuing a refund. All other debts should be paid directly by the student.

A student whose University account is overdue or who in any other manner has an unpaid financial obligation 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.

REFUNDS FOR WITHDRAWAL FROM THE UNIVERSITY

Note: No refunds are made without an official withdrawal. Policies for official withdrawal, including medical and mandatory administrative withdrawal, are found under Withdrawal From the University in the Academic Records and General and Enrollment Standards section of this catalog.

Reduction of tuition and fees is determined by the effective date of the withdrawal and is based on the schedule listed in the *Financial Information Bulletin*, which can be accessed online at www.smu.edu/bursar ("Financial Bulletin" link).

Note: 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 (based on the *Financial Information Bulletin*); 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 the Financial Aid Advising Office.

Medical withdrawals and mandatory administrative withdrawals allow a prorated refund of tuition and fees.

PAYMENT PLAN OPTIONS

SMU Monthly Payment Plan

The SMU TuitionPay Payment Plan administered by Sallie Mae allows term charges to be paid in monthly installments. Students can enroll in a payment plan at www.tuitionpaymentplan.com/smu. Sallie Mae consultants are available at 877-279-6092 to answer questions or help with the online enrollment process.

Annual payment plans are available in 12-month, 10-month and eight-month formats. Term payment plans are available in four-month, five-month and six-month formats. The summer payment plan is three months.

SMU Prepayment Plan

The SMU Prepayment Plan (a single payment up front for all terms) allows families to avoid the effects of tuition and fee increases by paying for two, three or four years in one single payment at the current rate of tuition and fees. Questions should be addressed to the Division of Enrollment Services, Southern Methodist University, PO Box 750181, Dallas TX 75275-0181; phone 214-768-1096.

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. Schools and departments that offer master's or Ph.D. degrees offer a significant number of tuition scholarships and teaching or research assistantships each year. For more information, students should contact the appropriate school or 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 www.fafsa.gov. A personal identification number can be obtained at www.pin.ed.gov and used to electronically sign the application. The SMU Title IV school code number is 003613. More information is available online at www.smu.edu/financial_aid.

OAK RIDGE ASSOCIATED UNIVERSITIES

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 U.S. Department of Energy 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 additional information about ORAU and its programs, students should contact Dr. James E. Quick, ORAU councilor for SMU (214-768-4345), Monnie E. Champion, ORAU corporate secretary (423-576-3306), or visit the ORAU website at www.orau.org.

SMU-IN-PLANO

www.smu.edu/plano

SMU opened a campus in Plano's Legacy Business Park in fall 1997 to 1) extend SMU's resources to meet the educational needs of residents in Collin County and beyond, 2) make enrollment in graduate-level programs more convenient for working professionals and 3) collaborate with area businesses by offering programs to serve the training needs of their employees and by providing corporate meeting space.

SMU-in-Plano serves more than 800 adult students each year (excluding enrollment in noncredit courses) through a variety of full-time, evening and weekend programs leading to master's degrees and/or professional certificates in business administration, counseling, dispute resolution, liberal studies, education and learning therapies, engineering, and video game technology (The Guildhall at SMU). During the summer, nearly 2,000 children participate in a variety of programs designed to enhance their academic skills. The campus also provides important outreach services to the surrounding Collin County communities; these services include the Mediation and Arbitration Center, the Diagnostic Center for Dyslexia and Related Disorders, and the Center for Family Counseling.

More information is available online or through the SMU-in-Plano office: 5236 Tennyson Parkway, Building 4, Plano TX 75024, 972-473-3400.

ENGLISH AS A SECOND LANGUAGE PROGRAM

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. Dedman College offers the following ESL resources to students from all schools and departments of SMU. Students may apply on the ESL website. More information about the ESL Program is available on the website (www.smu.edu/esl) or from the director, John E. Wheeler (jwheeler@smu.edu).

The Courses (ESL)

ESL 1001 (0). 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 that 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 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 free of charge, noncredit bearing, and transcripted as pass or fail. *Prerequisite:* ESL Program approval required.

ESL 1002 (0). 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. *Prerequisite:* ESL Program approval required.

ESL 20XX (0). INTENSIVE ENGLISH PROGRAM. All 2000-level ESL courses are exclusive to the Intensive English Program. 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 6-week summer term. This is a noncredit, nontranscripted program, and separate tuition fees are charged. *Prerequisite:* ESL Program approval required.

ESL 3001 (0). 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 transcripted as pass or fail. *Prerequisite:* ESL Program approval required.

ESL 3002 (0). 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 transcripted as pass or fail. *Prerequisite:* ESL Program approval required.

ESL 4001 (0). 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 transcripted as pass or fail. *Prerequisite:* ESL Program approval required.

ESL 6001, 6002. SEMINAR FOR INTERNATIONAL TEACHING ASSISTANTS. Graduate students who speak English as a second language prepare for their teaching responsibilities with undergraduate students taking University Curriculum courses. The main components include language skills needed as international teaching assistants, ITA-related teaching methodology, cross-cultural communication within the American classroom, and presentation skills. Also, examination of case studies, microteaching demonstrations, and periodic out-of-class individual consultations on the student's language and pedagogical skills. The course is free of charge, noncredit bearing, and transcripted as pass or fail.

RESIDENCE ACCOMMODATIONS

The mission of the Department of Residence Life and Student Housing is to advance the goals and objectives of the University by creating residential communities that empower residents to value learning, citizenship and leadership. To support SMU's mission, goals and objectives, RLSH develops and sustains the residence halls and apartments as communities that support the broad range of student needs. To this end, RLSH seeks opportunities to promote an intellectual culture in residence halls that complements an already flourishing campus social culture. The University prides itself on offering a full living and learning experience for its resident students. RLSH is responsible for the campus residential community, including all residence halls, approximately 40 SMU-owned apartments and 10 SMU-owned Greek chapter houses. This responsibility includes making sure that facilities are well maintained and that students have opportunities to grow personally and excel academically.

Housing Policy for All Students

All incoming first-year undergraduate students are required to live on campus for two years. Exceptions may be granted at the discretion of the dean of RLSH to those students from Dallas/Fort Worth who live with a parent or legal guardian in the primary residence of the parent or guardian. For housing purposes, the *two years* means the first two years of college. Incoming transfer students who are over the age of 16 and under the age of 20 are required to live on-campus for their first year at SMU. For 2014–2015, upperclass, transfer and graduate students are not required to live on campus but may apply on a space available basis.

Applications for Residence

New graduate students should submit the completed application and contract to RLSH with a check or money order for $100 made payable to Southern Methodist University for the nonrefundable housing deposit. Notification of assignment will be made by RLSH.

The housing license agreement is for the full academic year (fall and spring terms). Room charges for the fall term will be billed and are payable in advance of the term for students who register before August 1, and room charges for the spring term will be billed and are payable in advance of that term for students who register before December 1. Students who register after these dates must pay at the time of registration. Room charges 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 dean of RLSH before acceptance of the housing license agreement. It is important that applicants become familiar with the license agreement, as it is a legally binding document.

Graduate Residence

The Department of Residence Life and Student Housing operates one apartment residence hall designated for graduate students." Hawk Hall, a one-bedroom-apartment facility, houses single graduate students and married students (graduate and undergraduate) with families. Families with no more than two children may be housed in Hawk Hall.

Special Housing Needs

Students having special housing needs because of a disability should contact the SMU Office of Disability Accommodations and Success Strategies in order to establish eligibility for accommodations. When applying for housing, students should also submit information to RLSH regarding a request for accommodations. DASS and RLSH will work together with the student on their specific situation to make necessary accommodations.

General Housing Information

Each apartment is equipped with a telephone, local telephone service, voice mail system and wireless 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 the graduate hall. For more information, students should visit www.smu.edu/housing or contact the Department of Residence Life and Student Housing, Southern Methodist University, PO Box 750215, Dallas TX 75275-0215; phone 214-768-2407; fax 214-768-4005; housing@smu.edu.

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 their own interests and their integrity as individuals will suffer if they condone dishonesty in others.

The Honor System

All SMU students, with the exception of graduate students enrolled in the Cox School of Business, Dedman School of Law, Perkins School of Theology, or Simmons School of Education and Human Development, are subject to the jurisdiction of the Honor Code (www.smu.edu/studentlife, "Student Handbook" link) and as such are required to demonstrate an understanding of and to uphold the Honor Code. In support of the Honor Code, the Honor Council has the responsibility to maintain and promote academic integrity. 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, nominated by the Faculty Senate, also serve on the Honor Council.

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 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. As part of the Office of the Dean of Student Life, the Student Conduct and Community Standards Office (www.smu.edu/studentconduct) 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.

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.

Due respect for the entire University community, faculty, staff and one's fellow students is always expected. The University expects all students to be responsible citizens and to abide by all federal, state and local laws. The University Code of Conduct applies to students both on and off campus. It is the University's expectation that students will avoid behaviors such as, but not limited to, the misuse of drugs and alcohol, dishonesty, gambling, hazing, or behavior that endangers or threatens to endanger the health and safety of any person.

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.

Conduct Review Process

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. The purpose of the conduct review process is to encourage personal responsibility.

Depending on the degree of misconduct, a student may be subject to sanctions ranging from an informal warning to expulsion from the University. In addition, a student may be assigned educational sanctions designed to promote personal growth and development. 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.

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 related to the conduct review process 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*, which is available online at smu.edu/studentlife.

VETERANS SERVICES

The Division of Student Affairs provides a coordinator of veteran support and services through the Office of the Dean of Student Life. The coordinator helps veterans navigate the campus community and connect with available resources on campus and in the greater Dallas community. A chartered student organization, U.S. Military

Veterans of SMU (SMU MilVets), meets regularly to provide support to fellow veterans and to participate in fundraisers, care package drives, tailgating on the Boulevard during football games and other activities during the school year. In addition, the University Registrar's Office certifies veterans each term for their benefits under federal programs and the Office of Financial Aid works to provide individual aid packages. More information regarding services and benefits for veterans is available at www.smu.edu/veterans.

WOMEN'S CENTER

www.smu.edu/womenscenter

The Women's Center for Gender and Pride Initiatives of Southern Methodist University empowers students within the University to increase awareness and understanding of gender equity issues by eliminating barriers, diminishing prejudices and creating a supportive climate and space for all. Through advocacy, information, referral services and leadership experiences, the Women's Center provides a safe haven for students struggling with issues of injustice and oppression. Student organizations advised here include the Women's Interest Network, Campus YWCA, Women in Science and Engineering, and Spectrum, the lesbian, gay, bisexual, transgender and ally organization. Also housed in the Women's Center is the SMU Women's Symposium (www.smu.edu/womsym), which is part of The Education of Women for Social and Political Leadership series, established in 1966. The center provides an informal, homelike atmosphere where members of the SMU community can meet.

OFFICE OF THE CHAPLAIN AND RELIGIOUS LIFE

www.smu.edu/chaplain

The Office of the Chaplain and Religious Life offers resources of pastoral care and theological reflection that nurture the spiritual maturation, moral and ethical vision and character of students, faculty and staff.

Chaplain Stephen W. Rankin is the pastor and minister to the University community. Chaplain Rankin leads and preaches at University Worship, an ecumenically Christian all-University service of worship in the Methodist tradition, in Perkins Chapel each Sunday during the term. Students, faculty and staff are invited to participate in this service through music, scripture readings or other expressions of worship. Other services, including the University Service of Memory, Ash Wednesday Service and memorial services as needed, are also planned and implemented by the Office of the Chaplain.

Presently, there are more than 30 religious life organizations. Alongside the Christian groups aligned with denominations, local Dallas-area congregations or national parachurch ministries, SMU also has an active Hillel chapter for Jewish students, a bustling Muslim Student Association and other faith groups of various traditions. A large number of undergraduate, graduate and professional students, as well as many of SMU's faculty, staff and administrators, participate in these dynamic religious communities.

In cooperation with the Department of Residence Life and Student Housing, the Office of the Chaplain places a resident community chaplain in each residence hall. The RCC is a graduate student at the Perkins School of Theology who provides a listening ear and pastoral presence for students, helping them navigate the sometimes confusing concerns of life.

Chaplains are available for personal counseling and spiritual direction with students, faculty and staff during office hours. The Office of the Chaplain is located in the Hughes-Trigg Student Center, suite 316. Adjacent to this office is the Quiet Place, a setting for meditation, prayer and reflection for all faiths. The Quiet Place is open daily and available with no prior reservation needed.

DISABILITY ACCOMMODATIONS AND SUCCESS STRATEGIES

DASS offers comprehensive support services for any SMU student with a disability. Services include classroom accommodations for qualified students with a learning disability and/or attention deficit hyperactivity disorder, as well as physical accessibility and accommodations for other conditions such as physical, visual, hearing, medical or psychiatric disorders. For undergraduate students, academic coaching with DASS learning specialists is available in the areas of transitioning, learning strategies, educational planning and self-advocacy. More information on the accommodations process and DASS resources is available at www.smu.edu/alec/dass.

HEALTH SERVICES

SMU Memorial Health Center

www.smu.edu/healthcenter

The University's health facilities are temporarily located at 3014 Daniel Avenue. Services include an outpatient primary care clinic, pharmacy and lab. Counseling and Psychiatric Services and the Office for Alcohol and Drug Abuse Prevention are located on the second floor. The Health Center 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, registered nurses, medical assistants and lab technologists. Physicians are available by appointment 8:30 a.m.–4:30 p.m., Monday through Friday. For appointments and health information, students should call 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 non-major 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. Students should refer to the Health Center website (www.smu.edu/healthcenter) for hospital information and location of an urgent care facility.

Costs. Undergraduate and graduate students pay a mandatory health center fee and receive fully covered primary care physician services at the Health Center for that term, as well as counseling and psychological services and access to health education programs. Any lab work, pharmacy items and medical supplies are charged at reasonable rates.

Mandatory Health Insurance Policy. To ensure that students have appropriate health care coverage, SMU requires all domestic students, both undergraduate and graduate, taking nine or more credit hours to have health insurance through either an individual/family plan or the University-offered plan. All international students

taking one or more credit hours must enroll in the University-offered plan unless they have a special waiver personally granted by the Health Center staff.

SMU's mandatory policy requires those students with the enrollment status mentioned above to provide documentation of current insurance coverage or to enroll in the Student Health Insurance Plan by the drop/add date each term. Students can enroll in SHIP, after they have enrolled for classes, by selecting the "Health Insurance" button on the "Student Center" component of My SMU. A domestic student who already has private health insurance coverage must waive SHIP coverage to avoid automatic enrollment into the plan and thereby have the semiannual premium charge applied to his or her University account. Waivers will not be accepted nor will changes be made after the deadline each term. For more information and instructions on how to WAIVE or ELECT coverage, students should visit the website www.smu.edu/healthinsurance. Students who elect SHIP for the fall term will automatically be re-enrolled in mid-December unless the insurance office receives notification of the desire to waive for spring. **Note**: Health insurance is separate from the student Health Center fees and is paid for separately.

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, and the pharmacy will transmit pharmacy claims to a student's insurance company if provided with the student's pharmacy benefits information.

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 (undergraduate, graduate, part-time and full-time, to include international and IEP/ESL 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 also submit to the Health Center immunization records that provide proof of immunization against measles, mumps and rubella. These MMR immunizations must be documented by a physician, public health record, military health record or school health record. Students will not be allowed to register without immunization compliance.

Effective January 1, 2012, Texas state law requires that all new students under the age of 30 must provide documentation demonstrating they have been vaccinated against bacterial meningitis. The documentation must show evidence that a meningitis vaccine or booster was given during the five-year period preceding and at least 10 days prior to the first day of class of the student's first term. Students should provide the documentation at least 10 days before the first day of class. Students seeking exemption from this requirement due to health risk or conscience, including religious belief, should see the second page of the SMU medical history health form. More information is found under Final Matriculation to the University in the Admission to the University section of this catalog.

Students are encouraged to check their My SMU account for immunization status. Immunizations are available at the Health Center. Health history forms are available on the Health Center's website at www.smu.edu/healthcenter.

Class Absence Due to Illness. Students should schedule appointments with physicians at times when they do not have classes. The Health Center does not issue excuses from classes for illness. Students should refer to the Health Center website (www.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 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, sexual identity, eating/body image concerns and sexual assault/sexual harassment matters. Any laboratory tests or pharmaceuticals ordered will be charged to the student. For more information regarding scheduling appointments, students should call 214-768-2277 between 8:30 a.m. and 5 p.m., Monday through Friday, or visit www.smu.edu/counseling.

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, students should 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. More information is available at www.smu.edu/liveresponsibly.

Office of Health Education and Promotion. This office serves as a resource for health information on campus. It 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. More information is available from the Health Center (telephone: 214-768-2393; website: www.smu.edu/healthcenter/healtheducation.

CHILD CARE

SMU provides a licensed child care center for children ages 1 month to 5 years on a space-available basis. More information is available at www.smu.edu/childcare or from the director of the center at SMU Preschool and Child Care Center, Southern Methodist University, PO Box 215, Dallas TX 75275-0215; phone 214-768-2278.

RECREATIONAL SPORTS

for recreational sports and wellness. The center provides racquetball courts, aerobic studios, an indoor running track, basketball courts, sand volleyball courts (indoor and outdoor), a climbing wall, a bouldering wall, a 25-meter recreational pool with five lanes, 15,000 square feet of fitness and weight equipment, and a café next to the lobby area. These facilities are open to SMU students, faculty, staff and members.

A variety of services and programs are available, including fitness classes, intramural sports, sport clubs, the Outdoor Adventure program, personal training, personal assessments, massage therapy, swimming lessons and camps.

CONTINUING AND PROFESSIONAL EDUCATION

The Office of Continuing and Professional Education provides noncredit courses that address different cultural, scholarly, personal and professional topics for the community, a practice that has been part of the SMU tradition since 1957. CAPE offers a selection of courses for open enrollment each fall, spring and summer term. Additional information is available at www.smu.edu/cape.

Personal Enrichment. CAPE classes – historically, *Informal Courses for Adults* – are generally short sessions on topics for enjoyment and reflection. Courses offered for personal enrichment include several major areas of exploration: personal finance and life planning, communication and workplace skills, history, literature and film, culture and travel, and the fine arts (e.g., studio art, music, architecture, photography and art history). CAPE also offers noncredit language conversation courses, including courses in Spanish, French, Italian, Mandarin Chinese and American Sign Language.

Test Preparation. Study courses for the SAT, ACT, GRE, GMAT and LSAT are offered throughout the year. Information is available at www.smu.edu/testprep.

Professional Training and Development. For those who are seeking professional achievement or a new career direction but who are not interested in a traditional undergraduate or graduate degree-granting program, CAPE offers noncredit courses to enhance workplace skills, as well as noncredit **Certificate Programs** in

- Nonprofit leadership, together with the Center for Nonprofit Management (www.smu.edu/nonprofit).
- Paralegal studies (www.smu.edu/paralegal).
- Graphic design (www.smu.edu/graphicdesign).
- Web design (www.smu.edu/webdesign).
- Financial planning, which includes the option to test for national certification (www.smu.edu/cpfp).
- Communications, in conjunction with the Meadows School of the Arts, Division of Communication Studies.
  - Social media and digital communications (www.smu.edu/digicomm).
  - Business and professional communications (www.smu.edu/bpc).

Students complete certificate programs by taking a series of classes over weeks or years, depending on the specialization and the student's schedule. Cohort and independent options are available, with some classes being offered online. Upon completion of the series of sessions, students receive a noncredit transcript documenting the sessions attended and a certificate of completion from Continuing and Professional Education at SMU.

SMU's Summer Youth Program offers one-week, special-interest enrichment workshops throughout the summer for those entering grades K–12. More information is available at www.smu.edu/SummerYouth.

Online Learning. CAPE partners with national leaders in online teaching and learning to offer a growing library of self-paced, practical, career-enhancing courses that can be accessed from home and office computers. Additional information is available at www.smu.edu/capeonline.

ACADEMIC RECORDS AND GENERAL AND ENROLLMENT STANDARDS

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. A complete *University Policy Manual* is available at www.smu.edu/policy. Additional information regarding rules and regulations of the University can be found in this catalog.

GENERAL POLICIES

Confidentiality of Education Records

The Family Educational Rights and Privacy Act of 1974 is a federal law that grants 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 its own FERPA-based guidelines that are available at the University Registrar's Office FERPA website. Policy 1.18 of the *University Policy Manual* 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 My SMU Self-Service that it be withheld, 2) information authorized by the student through My 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. Additional information is available online at www.smu.edu/LegalDisclosures/FERPA.

Student File Number

The University assigns each student an eight-digit SMU identification number. The student should furnish the SMU ID number on all forms when requested, as this number is the primary means the University has to identify the student's academic records and transactions related to the records.

Name Change

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

Email and Mailing Addresses, Telephone, and Emergency Contact

Each student must provide the University Registrar's Office with a current home address, telephone number and 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 My SMU, the University's Web-based self-service system. Students may be prevented from enrolling if their information is insufficient or outdated. Changes to parent information should be reported by contacting records@smu.edu, and the email should include the student's full name and SMU student ID number.

The University issues all students an email address. Students may have other email addresses, but the University-assigned email 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 email addresses on file. It is the responsibility of students to keep all their addresses current and to regularly check communications sent to them since they are responsible for complying with requests, deadlines and other requirements sent to any of their mailing addresses on file or to their SMU email.

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 do not have cellular telephones or do not wish to report the numbers should provide this information to the University through My SMU Self-Service. 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" in My SMU.

Ethnicity

SMU requires that a valid ethnic group category be on file for all students. SMU's policies and the Family Educational Rights and Privacy Act of 1974 protect the confidentiality and privacy of this information. A student's ethnic group category can be viewed in My SMU Self-Service Student Center.

U.S. Citizens or Permanent Residents. Ethnicity is self-determined. Students of multiple ethnic backgrounds may select multiple ethnic group categories. If the ethnic group value is incorrect, the student should go to the University Registrar's Office in the Laura Lee Blanton Student Services Building and complete an Ethnic/Racial Category Update Form.

International Students Living in the U.S. While Attending School. Selecting an ethnic group category is not required unless the student becomes a U.S. citizen or permanent resident.

Transcript Service

A transcript is an official document of the permanent academic record maintained by the University Registrar's Office. 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's Office for all students. Copies of high school records and transfer transcripts from other schools must be requested from the institutions where the coursework was taken.

Transcripts are $12.25 per copy. Additional copies in the same request mailed to the same address are $3.50. Additional copies mailed to different addresses are $12.25 a copy. PDF transcripts are $16.00 per email address and are available only for students who attended after summer 1996. **Note:** No incomplete or partial 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. Instructions for requesting a transcript to be mailed or picked up on campus are available at www.smu.edu/registrar ("Transcript Requests" link). A student may request his or her official transcript through the online My SMU Student Center. Requests are processed through the National Student Clearinghouse. Telephone and email requests are not accepted. Students or their specified third party can pick up their transcripts at the University Registrar's Office, 101 Blanton Student Services Building. Transcripts may be delayed pending a change of grade, degree awarded or term grades.

SMU is permitted, but not required, to disclose to the parents of a student any 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 www.smu.edu/LegalDisclosures/FERPA/Forms.

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

Veterans

The University Registrar's Office certifies veterans each term for their benefits under federal programs, including the Yellow Ribbon Program. Most academic programs at SMU qualify for U.S. Department of Veterans Affairs benefits, making an SMU education accessible and affordable. Veterans are required to provide specific documents before they can be certified with the VA's Veterans Benefits Administration. Specific information regarding the certification process is available from the University Registrar's Office at www.smu.edu/registrar ("Veterans Affairs" link).

Final Examinations

Final course examinations shall be given in all courses where they are appropriate, must be administered as specified on the official examination schedule and shall not be administered during the last week of classes. Exceptions to the examination schedule may be made only upon written recommendation of the chair of the department sponsoring the course and with the concurrence of the dean of that school, who will allow exceptions only in accordance with guidelines from the Office of the Provost.

Academic Grievance and Appeals Procedures for Students With Disabilities

The University policy for academic grievance and appeals procedures for students with disabilities is available in the Office of Disability Accommodations and Success Strategies and the University Registrar's Office.

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 students engaged in graduate studies. Individuals who enroll for fewer than these minimum hours are designated as 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 theatre 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 director or academic dean or the dean for the Office of 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 and is recognized by the academic dean or director as a full-time or part-time student, and if such recognition is approved by the provost.

Cautionary Note. Federal financial aid agencies and some other agencies require a minimum number of hours of enrollment for full-time status and do not make exceptions for internship, co-op or student-teaching enrollments. Students on financial aid should consult a Financial Aid Office adviser regarding minimum enrollment requirements for their situation.

Minimum and Maximum Course Loads. Minimum and maximum course loads allowed are based on the school of record.

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.

Transfer Courses From Other Institutions

The policy for transfer credit is found under the Master of Science and Master of Arts Degrees section of this catalog.

Official college transcripts are required for all college-level work attempted, regardless of transferability. Military transcripts are also required for students receiving VA benefits; more information is available at www.smu.edu/registrar ("Veterans Affairs" link). Students are responsible for making sure a transcript of all transfer work attempted is sent to the University Registrar's Office immediately following completion of the work.

ENROLLMENT POLICIES

Course Scheduling and Enrollment Cycles

When students enter their school of record and into a specific degree program, they are assigned an academic adviser. Students should consult with the adviser for course scheduling, schedule changes, petitions, degree requirements and other such academic concerns. Advisers normally will have established office hours. The academic dean's office or the school's records office monitors progress and maintains official degree plans for all students in a school. Students should schedule conferences with staff in the dean's office or the school's records office upon admission to a school and prior to their final term to ensure that they are meeting all University and graduation requirements.

Each fall, spring and summer term has an enrollment period during which the formal process of enrollment in the University is completed. Prior to each enrollment period, the University Registrar's Office will publish enrollment instructions.

Each student is personally responsible for complying with enrollment procedures and for ensuring the accuracy of his or her enrollment. Students are expected to confirm the accuracy of their enrollment each term. Students who discover a discrepancy in their enrollment records after the close of enrollment for the term should immediately complete an Enrollment Discrepancy Petition. Petitions are to be submitted to the appropriate academic dean's office or records office within six months of the term in which the discrepancy appeared; contact information for submission of an Enrollment Discrepancy Petition can be viewed on the University Registrar's Office website at www.smu.edu/EnrollmentDiscrepancy. Petitions submitted later than six months after the discrepancy may not be considered.

Schedule Changes

The deadline for adding courses, dropping courses without grade record and changing sections for each enrollment period is listed on the Official University Calendar (www.smu.edu/registrar). Students are encouraged to seek assistance from their advisers when considering whether to add or drop a course. A student may drop a course with a grade of *W* (Withdrew) through approximately midterm by using the student My SMU Self-Service. The specific deadline is listed on the Official University Calendar.

After the deadline date on the Official University Calendar, the student may not drop a class. All schedule changes must be processed by the deadline date specified on the Official University Calendar. **Note:** Schedule changes are not complete for official University record purposes unless finalized in the University Registrar's Office.

Student-Athletes. Students must consult with the Athletic Compliance Office prior to dropping a course. In the consultation, the student will review the effects the drop might have on his or her athletic participation and financial aid. After the consultation, the Athletic Compliance Office will update My SMU Self-Service to allow the student to process the drop, if necessary. The consultation is advisory; students are responsible for their enrollment. For assistance regarding scholarships or other aspects of being a student-athlete, students should contact the Office of the Assistant Athletic Director for Student-Athlete Development.

International Students. Students must consult with the International Center prior to dropping a course. If dropping a course will cause the student to be enrolled in

fewer than the required number of hours to remain a full-time student, the student's immigration status could be affected. After the consultation, the International Center will update My SMU to allow the student to process the drop, if necessary. The consultation is advisory; students are responsible for their enrollment.

Students on Merit or Need-Based Financial Aid. Students should consult with their financial aid adviser prior to dropping a course. If dropping a course will cause the student to be enrolled in fewer than the required number of hours to remain a full-time student, the student's financial aid status may be affected. After the consultation, the student may drop a course through My SMU Self-Service. The consultation is advisory; students are responsible for their enrollment. Questions regarding this procedure or financial aid should be directed to the Office of the Associate Financial Aid Director.

Withdrawal From the University

Note: Policies on refunds for withdrawal from the University are found in the Financial Information section of this catalog and in the *Financial Information Bulletin*, which can be accessed online at www.smu.edu/bursar ("Financial Bulletin" link). No refunds are made without an official withdrawal.

Students should be aware of the difference between a *drop* and a *withdrawal* and remember that they have different deadlines and separate financial policies. The deadlines for each are posted each term on the Official University Calendar at www.smu.edu/registrar. A *drop* occurs when a student removes one or more courses from his or her schedule and remains enrolled in at least one credit hour for the term. A *withdrawal* occurs when removing the course or courses will result in the student being enrolled in **zero** hours for the term.

If a student removes all courses from his or her schedule **prior to the first day of the term**, the transaction is considered a *cancellation* and does not result in financial penalty or impact the student's transcript.

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 and secure approval from his/her academic dean. The academic dean's office will then submit the form to the Office of the University Registrar. The effective date of the withdrawal is the date on which the Student Petition for Withdrawal is processed in the University Registrar's Office. Discontinuance of class attendance or notification to the instructors of intention to withdraw does not constitute an official withdrawal.

The enrollment of students who withdraw on or before the fifth day of regular classes as listed on the Official University Calendar will be canceled. Courses and grades are not recorded for canceled enrollments; however, the student will owe a portion of his/her tuition and fees. Additional information is available in the *Financial Information Bulletin*, which can be accessed online at www.smu.edu/bursar ("Financial Bulletin" link). A student who withdraws after the fifth class day will receive the grade of *W* in each course in which he or she enrolled.

Medical withdrawals and mandatory administrative withdrawals allow a prorated refund of tuition and fees and have conditions that must be met prior to reenrollment at SMU. Medical withdrawals can only be authorized by a licensed physician or psychologist counselor in the SMU Memorial Health Center. Mandatory administrative withdrawals can be authorized only by the vice president for student affairs. As a matter of University policy, and in compliance with federal regulations, retroactive medical withdrawals cannot be granted. The last day for a medical with-

drawal is the last day of class instruction for the term from which the student is withdrawing.

Withdrawing students living in SMU housing must check out of the residence halls with the Department of Residence Life and Student Housing per established procedures.

Audit Enrollment (Course Visitor)

Individuals desiring to audit (visit) a class, including those concurrently enrolled for regular coursework, are required to process an Audit Enrollment Request Form. Forms are available at www.smu.edu/registrar ("Forms Library" link). 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. The individual's name does not appear on class rosters or grade rosters.
3. Regular admission and enrollment procedures are not conducted for auditors.
4. The audit fee is nonrefundable.
5. If credit is desired, the course must be enrolled for and repeated as a regular course, and the regular tuition must be paid.

No-Credit Enrollment

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, 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 of classes in summer sessions; the second day of classes in intersession terms) 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, and the student is listed on class rolls. This enrollment is different from audit enrollments, for which no enrollment or grade is recorded.

Class Attendance

Regular class attendance is required. The instructor of each class announces at the beginning of the course policies regarding the effect of class attendance on the student's standing in the course. These policies may include dropping a student from the course for nonattendance after a certain number of absences. All reasons for absence should be submitted at once to the instructor.

The satisfactory explanation of absence may release a student from disciplinary action but does not relieve a student from responsibility for the work of the course during his or her absence. A student who misses an announced test, examination or laboratory period in a regular course of study and has the permission of the instructor may be given an opportunity to make up the work at the instructor's convenience. The instructor determines in all instances the extent to which absences and tardiness affect each student's grade.

Students may be dropped by a course instructor or academic dean for nonattendance or tardiness with a grade of *W* until the calendar deadline to drop. After the deadline, students must remain enrolled in the course.

Students may also be dropped by a course instructor for inappropriate classroom behavior. The instructor must submit the request by the University deadline to drop.

After the deadline, the student must remain enrolled in the class and receive a final grade of *F*.

Students who miss two successive class meetings during the official add-drop period at the beginning of each term are subject to being dropped from the class. To avoid this possibility, students should contact the instructor or the department concerned immediately following such a series of absences.

A student who has a passing grade in a course at the time of the final examination, but who misses the examination and satisfies the dean that the absence was unavoidable, may secure from the dean permission to take the examination at a time convenient for the instructor.

Absence Due to Illness

SMU's Memorial Health Center does not provide documentation for granting excused absences from class. If students are absent for illness, they should talk to their professors about how they might catch up with the material missed. If students are seriously ill and require hospitalization or an extended absence, students should talk to their professors and the Office of Student Life to decide how to deal with the interruption in their studies. To facilitate communication with their professors about their absence, students may submit the Absence from Class Form available at www.smu.edu/healthcenter.

Interpretation of Course Numbers

Each SMU course has a four-digit course number. The first number indicates the general level of the course.

1000–1999	First-year
2000–2999	Sophomore
3000–3999	Junior
4000–4999	Senior
5000–5999	Senior or Graduate
6000–9999	Graduate

The second digit specifies the number of credit hours; exceptions are noted below.

Digit	*Credit Hours*
0	0, .5 or 10–15
1	1 or 1.5

The third and fourth digits are used to make the course number unique within the department.

GRADE POLICIES

A student's grades are available to him or her through My SMU Student Center.

Grade Scale

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's Office. In order for a course to count toward a Lyle graduate degree, a grade of *C*- or higher must be

earned. Any grade lower than a *C-* is not passing, but it will be counted in the cumulative graduate GPA.

Grades	*Description*	*Grade Points per Term Hour*
A	Excellent Scholarship	4.000
A-	Excellent Scholarship	3.700
B+	Good Scholarship	3.300
B	Good Scholarship	3.000
B-	Good Scholarship	2.700
C+	Fair Scholarship	2.300
C	Fair Scholarship	2.000
C-	Fair Scholarship	1.700
D+	Poor Scholarship	1.300
D	Poor Scholarship	1.000
D-	Poor Scholarship	0.700
F	Fail	0.000
P, CR	Pass, Credit	*
I	Incomplete	*
NC	No Credit Received	*
X	No Grade Received in Registrar's Office	*
WP/W	Withdrawal Passing/Withdrew	*

Note: Asterisks denote grades not included in a student's GPA.

Grade of F, D or W

Failing is graded *F*. If the student's work is incomplete, poor quality and not acceptable, a grade of *F* will be given. 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 *D* in a course that is a prerequisite to another course should consult with their advisers about repeating the course so that they will be adequately prepared for work in the following course.

The grade of *W* cannot be recorded unless completion of the 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 because the act of officially dropping/withdrawing is irrevocable.

Grade of Incomplete

A student may temporarily receive a grade of Incomplete (*I*) a substantial portion 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.

The grade of *I* is normally changed to a final grade within one year but no later than the time of graduation.

At the time a grade of *I* is given, the instructor must stipulate in writing to the student the requirements and completion date that are to be met and the final 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 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.

The grade of *I* in a course does not authorize a student to attend or enroll in the course during a later term. Graduation candidates must clear all Incompletes prior to the deadline on the Official University Calendar. 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.

Grade Point Average

A student's grade point average (cumulative GPA) 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 on the grade chart. The GPA is truncated, not rounded, at three decimal places.

Grade Changes

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 the request as a written petition, 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 re-evaluation 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 of grades 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 in cases where a grade is 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 University Registrar's Office.

Grades for Repeated Courses

Students will be allowed to repeat courses according to the following rules: Both the initial and the second grades will be recorded on the student's permanent academic record (transcript). Both grades will be included in the calculation of the student's cumulative GPA and in the determination of academic probation, suspension, dismissal, honors and graduation. Only the repeated course and not the initial credit hours count toward the number of hours needed for graduation.

Pass/Fail Option

Students should consult with their advisers before declaring the pass/fail option for any course, as some courses may not be taken pass/fail, and no courses taken for pass/fail credit can be used to satisfy academic curricular requirements for Lyle graduate degrees.

Grade Appeals

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 decision on 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 of the school offering 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 of the school offering 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.

ACADEMIC ADVISING AND SATISFACTORY PROGRESS POLICIES

Academic Advising

For an effective advising relationship, the student must be prepared when meeting with the adviser. The student must initiate the advising appointment. The adviser will give assistance to the student, but the student has the final responsibility for the accuracy of the enrollment, the applicability of courses toward the degree requirements, and his or her academic performance.

Students are assigned an academic adviser by their academic dean's office or records office. A student who enrolls without first meeting with his or her assigned academic adviser may be subject to sanctions including, but not limited to, cancellation of the term enrollment and restriction from the self-service enrollment functions.

Leave of Absence

A leave of absence is a temporary leave from the University – a kind of "time out" – that may be necessary during an academic career. Students may elect to take leaves of absence for a variety of reasons, including 1) medical reasons due to accident or illness, 2) family crises or other personal situation that requires an extended absence from school, 3) financial issues that may take time to resolve, and 4) academic difficulties that may best be handled by taking time to refocus on college work.

Typically, a leave of absence is for one term or one academic year. A student may extend a leave of absence by contacting his or her academic department representative. The process to return to SMU after a leave-of-absence period can be an easy one, especially if the student has gone through the steps to file for a leave of absence

and planned ahead for the return. Following SMU's leave-of-absence guidelines helps 1) assure that the degree requirements per the catalog of record when the student initially matriculated at SMU still apply upon return, 2) assist with financial aid processing, and 3) provide the support needed to return to SMU and successfully finish the degree.

The SMU Leave of Absence Policy provides students with a formal process to "stop out" of SMU for either voluntary or involuntary reasons. Typically, *a leave of absence* is for a temporary departure from the institution; however, *intended permanent withdrawals* from SMU will also be processed under the Leave of Absence Policy.

The first step to effect a leave of absence is for the student to arrange an appointment to meet with his or her academic adviser, who will then assist the student with the process.

Academic Progress

Failure to meet established minimum acceptable standards of academic or disciplinary performance can result in probation, suspension or dismissal. Information regarding disciplinary action can be found under Code of Conduct in the Student Affairs section of this catalog.

Graduate students must maintain a cumulative GPA of 3.000. If in any term the student falls below this cumulative GPA, the student will be placed on probation for one regular term. If at the end of the term of probation the cumulative GPA is not up to 3.000, the student may be removed from the program at the discretion of the dean's office or records office.

Definitions: Academic Probation, Academic Suspension, Academic Reinstatement and Academic Dismissal

Academic Probation. Academic probation is a serious warning that the student is not making satisfactory academic progress. A student on academic probation is still eligible to enroll and is considered in good standing for enrolling in classes and for certification purposes. Academic probation is not noted on the permanent academic record; however, a student on academic probation may be subject to certain conditions during the period of probation and will be subject to academic suspension if he or she does not clear academic probation.

Academic Suspension. Academic suspension is an involuntary separation of the student from SMU. Academic suspension is for at least one regular term. The term of suspension might be for a longer period depending on the policy of the school of record or the terms of the individual student's suspension.

The status of academic suspension is recorded on a student's permanent academic record. While on academic suspension, a student is not in good academic standing for certification purposes and is not eligible to enroll at SMU. Students who have served their suspension and who are eligible to return may not enroll for any intersession terms.

Credits earned at another college or university during a term of suspension may not be applied toward an SMU degree. A grade point deficiency must be made up through enrollment at SMU.

Academic Reinstatement. A student who has been on academic suspension once may apply for reinstatement to SMU. If reinstated, the student may enroll in classes, and he or she is considered in good academic standing for purposes of certification.

A student who is reinstated remains on academic probation until the conditions of academic probation are satisfied.

Academic Dismissal. A second suspension that is final results in an academic dismissal from the University. Academic dismissal is final, with no possibility of reinstatement or readmission. Academic dismissal is recorded on the student's permanent academic record.

Academic Petitions and Waivers

Petitions and/or requests for waivers concerning University requirements, graduation requirements and the evaluation of transfer work should be submitted to the dean's office or records office of the student's school of record.

Transfer Coursework

The policies for transfer coursework are found in this catalog under General Policies, Transfer Courses From Other Institutions in the Master of Science and Master of Arts Degrees section under Transfer of Credits.

GRADUATION POLICIES

Apply to Graduate

Students must file an Application for Candidacy to Graduate with their academic dean's office or records office no later than the last day of the first week of the term in which they will complete all degree requirements. Applications are filed through My SMU Self-Service by the deadline date on the Official University Calendar.

Students who file an application after the published deadline may be required to pay a nonrefundable late fee. Late applications may be denied after the start of the next term, and the Application for Candidacy to Graduate applied to the next conferral date. Students taking coursework at another institution and transferring the course(s) back to SMU are responsible for ensuring that the University Registrar's Office receives their official transcript in order for their degree to be conferred for the anticipated graduation term.

SMU has three degree conferral periods for most programs: fall (December), spring (May) and summer (August). Students who complete their degree requirements during a J Term (January) intersession, May term or August term will have their degrees conferred at the conclusion of the following conferral term.

Commencement Participation

An All-University Commencement Convocation is held in May for students on schedule and enrolled to complete degree requirements during the spring term. Students on schedule and enrolled to complete all degree requirements during the following summer session may also participate in the University Commencement Convocation, although their degrees will not be conferred until August. Students may also participate in departmental or school ceremonies following the University commencement according to the policies of the departments or schools.

An All-University December Commencement Convocation is held each year for students completing degree requirements during the fall term. Students who completed degree requirements during the previous summer session may also participate. Students on schedule and enrolled to complete all degree requirements during the following J Term (January) intersession may also participate in this ceremony, although their degrees will not be conferred until May.

A student may participate once in either the All-University Commencement Convocation in May or the All-University December Commencement Convocation for a given degree, but not both. To participate in a ceremony, a student must file with their academic dean's office or records office an Application for Candidacy to Graduate or Intent to Participate Form.

Statute of Limitations for Degree Plans

A student who has been readmitted to the University following an absence of more than three years will be expected to meet all current requirements for graduation.

LYLE GRADUATE PROGRAMS POLICIES AND PROCEDURES

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.

Approved Courses

Normally all graduate-level courses are numbered 6000 and above. Graduate students may take courses numbered below 6000 if they are 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 the Office of Research and Graduate Studies. If other specific prerequisites are needed, these are stated in departmental listings of courses.

Readmission

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. Additional information is found in the General Information section of this catalog.

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.

Students submit a final copy of the thesis/praxis/dissertation electronically as partial fulfillment of 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.

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. 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. More information is available at www.smu.edu/srk.

1. Academic Programs: www.smu.edu/srk/academics
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: www.smu.edu/srk/enrollment
Registrar, Blanton Student Services Building, Room 101
214-768-3417

a. Graduation Rates: The completion or graduation rate of the institution's certificate-seeking 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 SMU'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: www.smu.edu/srk/finaid
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- 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 Direct Loan or Federal Direct 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 / Bursar: www.smu.edu/srk; www.smu.edu/bursar
University Bursar, 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. DASS: www.smu.edu/alec/dass
Disability Accommodations and Success Strategies
Altshuler Learning Enhancement Center
214-768-1470

a. Description of the process for establishing eligibility for services and documentation guidelines.

b. Listings of the various on- and off-campus resources.

c. Discussions of transitioning to postsecondary education.

d. Tips for faculty on teaching and making accommodations.

6. Athletics: www.smu.edu/srk/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: www.smu.edu/srk; www.smu.edu/pd
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.

8. Student Appeals and Complaints

Southern Methodist University operates with integrity in all issues and is dedicated to preserving the rights of all members of the University community. Categories for which students may wish to reach out for advice and assistance and/or to submit an appeal or register a complaint are as follows: academics, code of conduct, discrimination, financial issues, honor code and privacy issues. An overview of the roles, responsibilities and procedures for complainants and the University is outlined in each of the areas below.

a. Academic Appeals and Petitions:
http://smu.edu/provost/acad_petitions.asp.

b. Student Code of Conduct:
http://smu.edu/studentlife/studenthandbook/PCL_03_Conduct_Code.asp.

c. Office of Institutional Access and Equity:
http://www.smu.edu/IAE.

d. Financial Responsibility and Confidentiality:
http://www.smu.edu/LegalDisclosures/FinancialAndConfidentiality.

e. Honor Code:
http://smu.edu/studentlife/studenthandbook/PCL_05_HC.asp.

In addition to the right to use internal University complaint procedures, every student has the right under federal law to use complaint processes provided by the state in which his or her campus is located.

For complaints regarding programs in Texas, students should contact the Texas Higher Education Coordinating Board, Office of General Counsel, PO Box 12788, Austin TX 78711-2788; email: studentcomplaints@thecb.state.tx.us.

Additional information about the Texas student complaints process may be found at www.thecb.state.tx.us ("Communications and Policy" link).

For complaints regarding programs in New Mexico, students should contact the New Mexico Higher Education Department, 2048 Galisteo Street, Santa Fe NM 85705-2300; telephone 505-476-8400.

Additional information about the New Mexico student complaints process may be found at www.hed.state.nm.us/students/complaints.aspx.

BOBBY B. LYLE SCHOOL OF ENGINEERING

The Bobby B. 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: Civil and Environmental Engineering; Computer Science and Engineering; Electrical Engineering; Engineering Management, Information and Systems; and Mechanical Engineering.

PROGRAMS AND COURSES

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:

CEE	Department of Civil and Environmental Engineering
CSE	Department of Computer Science and Engineering
EE	Department of Electrical Engineering
EMIS	Department of Engineering Management, Information and Systems
ENGR	Multidisciplinary Programs
ME	Department of Mechanical Engineering

Additional information is found under Interpretation of Course Numbers in the Enrollment Polices section of this catalog.

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*
CEE	Civil Engineering	M.S.C.E.	
CEE	Civil and Environmental Engineering		Ph.D.
CEE	Environmental Engineering	M.S.Env.E.	
CEE	Environmental Science	M.S.E.S.	
CEE	Sustainability and Development	M.A.	
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.
ENGR	Datacenter Systems Engineering	M.S.	
ENGR	Applied Science	M.S.	Ph.D.
ME	Mechanical Engineering	M.S.M.E.	Ph.D.
ME	Manufacturing Systems Management	M.S.	

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 3.000 on a 4.000 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 graduate school entry test 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 language proficiency test or its equivalent with a minimum score of 550 on the paper-based examination, 213 on the computer-based examination or 59 on the Internet-based examination on the reading/listening/writing sections. A score of 6.5 or better is also acceptable on the IELTS English language proficiency test. For further information, students should write to TOEFL, PO Box 899, Princeton NJ 08541, U.S.A., or visit 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. Additional information is found in under Lyle Graduate Programs Policies and Procedures in the Academic Records and General and Enrollment Standards section of this catalog.

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, students should 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. Additional information is found in the Financial Information section of this catalog.

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.

MASTER OF SCIENCE AND MASTER OF ARTS DEGREES

ADMISSION TO THE MASTER'S PROGRAM

Admission to the Graduate Division of the Lyle School of Engineering is a prerequisite to postbaccalaureate 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 3.000 on a 4.000 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 test score before being considered for admission, as follows:

- 550 – paper-based examination.
- 213 – computer-based examination.
- 59 – Internet-based examination (reading/listening/writing sections).

A score of 6.5 on the IELTS English language proficiency examination is acceptable in place of the above scores for the TOEFL 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:

1. The undergraduate program may have been taken so many years ago that it differs from what is offered today.
2. The undergraduate degree may have been completed in a field other than that in which the master's degree is sought.
3. 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.
4. 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* (3.000 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 3.000.

Admission to candidacy is automatically achieved when the student has obtained 12 term credit hours with a minimum 3.000 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 3.000 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 3.000 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 3.000 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 3.000 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 3.000 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 director of graduate studies. All such approved changes are incorporated into the student's plan of study and are placed on file in the office of the director of graduate studies.

PROBATION AND SUSPENSION

A student with a GPA lower than 3.000 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 director of graduate studies.

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 MULTIDISCIPLINARY PROGRAMS

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 they 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.

Master of Science With a Major in Datacenter Systems Engineering

The purpose of the SMU Data Systems Engineering program is twofold: to impart both the necessary breadth and depth for professionals preparing to fully participate in leadership roles as either managers or technologists.

Qualified students with undergraduate degrees in engineering, one of the physical sciences or mathematics, are required to complete 10 courses (30 term credit hours). Students entering the program with an undergraduate degree other than in engineering (one of the physical sciences or mathematics) may be asked to articulate the necessary courses.

Students are required to complete five required core courses and three Group I electives from one or more of the three optional specializations: facilities engineering; data engineering and analytics; and networks, virtualization and security.

The two additional Group II electives may be selected with adviser approval from the offerings of the Lyle School of Engineering, the Cox School of Business and the Dedman College Physics, Chemistry, Mathematics or Statistics departments. The student is responsible for ensuring that the prerequisites for the elective courses have been met.

The core courses, encompassing the activities of the data center, reflect the breadth of the technology as it is conducted in this industry. The Group I course concentrations serve to develop or extend competence in one or more of the technical fields of interest to the student. The Group II electives enable the student to build interests broadly, by selecting courses freely from the Lyle School of Engineering or the University as a whole.

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 requirements:

1. B.S. in one of the engineering disciplines, computer science, one of the quantitative sciences or mathematics.
2. A minimum of two years of college-level mathematics, including one year of college-level calculus.

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 requirements:

1. A total of 30 term credit hours (10 courses) with a GPA of at least 3.000.
2. Satisfactory completion of the core curriculum encompassing 15 term credit hours (five courses).
3. Satisfactory completion of nine term credit hours from Group I electives (three courses).
4. Satisfactory completion of six term credit hours from Group II electives (two courses).

Core Courses

CSE 5346 *or* **7346** Cloud Computing and Virtualization Technologies
CSE 7349 Data and Network Security
EE 7307 Telecommunications for Data Systems Engineering
EMIS 7357 Analytics for Decision Support
CEE/ME 5380 *or* **7380** Management of Industrial and Mission Critical Facilities

Group I Electives

Facilities Infrastructure Management

CEE 7325 Disaster Management
CEE 7370 Facilities Planning
CEE 7366 Introduction to Facilities Engineering Systems
CEE 7369 Electrical Mechanical and Piping Systems for Buildings
CEE 7384 Energy Management for Buildings
EE 7301 Power Management for Industrial and Mission Critical Facilities
EMIS 7347 Critical Infrastructure Protection/Security Systems Engineering
EMIS 8363 Engineering Finance *or* **ME 7330** Heat Transfer
ME 7335 Convection Cooling of Electronics
ME 7336 Intermediate Fluid Dynamics
ME 7344 Conductive Cooling of Electronics
ME/CEE 7383 Heating, Ventilating and Air Conditioning
ME 8385 Conduction Heat Transfer
ME 8387 Radiation Heat Transfer
CEE/ME 5381 *or* **7381** Site Selection for Industrial and Mission-Critical Facilities

Data Engineering and Analytics

CSE 7330 File Organization and Database Management
CSE 7340 Service Oriented Computing
CSE 7347 XML and the Enterprise
CSE 8316 User Interface Design
CSE 8321 Machine Learning
EMIS/CSE 7330 File Organization and Database Management
EMIS/CSE 8331 Data Mining
EMIS/CSE 8337 Information Retrieval
EMIS 7352 Information System Architecture
EMIS 7353 Information Systems Design Strategy

Networks, Virtualization and Security

EMIS 7382 Information Technology Security
EMIS 8364 Engineering Management
EMIS 8356 Information Engineering: A Global Perspective
CSE 7339 Computer System Security
CSE 7344 Computer Networks and Distributed Systems
CSE 7359 Software Security
CSE 8343 Advanced Operating Systems (Virtualization)
CSE 8349 Advanced Network and System Security
CSE 8352 (EE 8372) Cryptography and Data Security
EETS 7304 Internet Protocols
EETS 8311 Intelligent Networks

Group II Electives

With adviser approval, students may select two courses (six term credit hours) from any of the graduate-level courses offered by the Lyle School of Engineering, the Cox School of Business and the Dedman College Physics, Chemistry, Mathematics or Statistics departments.

THE 4+1 MASTER'S DEGREE PROGRAM

The 4+1 program permits the 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 3.000 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 3.000 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

Marc P. Valerin, **Director**

The graduate co-op program is an academic enrichment opportunity designed to give students the ability to apply their academic studies to real-world problems. Qualified students may apply to join this program and are eligible to enroll up to two terms of relevant professional work experience. 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 both a fall term and a spring term.
2. Students must be in good academic standing to be admitted to the co-op program with a minimum GPA of 3.000.
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 eligible employers.
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, department chair and director's approval).
   b. Legal agreement between SMU and employer (requires supervisor, Lyle dean and SMU provost approval).
   c. Curricular practical training request form for international students. (CPT form requires adviser, department chair and director's 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 eight business days 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 ENGR 8199 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

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.

THE COURSES (ENGR)

ENGR 7090 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7091 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7092 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7093 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7094 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7095 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7096 (0). MASTER'S THESIS.

ENGR 7097 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7098 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7099 (0). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7190 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7191 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7192 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7193 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7194 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7195 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7196 (1). MASTER'S THESIS.

ENGR 7197 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7198 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7199 (1). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7290 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7291 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7293 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7294 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7295 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7296 (2). MASTER'S THESIS.

ENGR 7297 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7298 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7299 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7390 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7391 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7392 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7393 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7394 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7395 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7396 (3). MASTER'S THESIS.

ENGR 7397 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7398 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7399 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 7696 (6). MASTER'S THESIS.

ENGR 8049 (0). GRADUATE FULL-TIME STATUS.

ENGR 8096 (0). DISSERTATION. 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.

ENGR 8196 (1). DISSERTATION. 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.

ENGR 8199 (1). GRADUATE ENGINEERING INTERNSHIP. This course represents a term of industrial work activity in connection with the Graduate Cooperative Education Program. The course grade is determined by a written report submitted by the student about the co-op assignment and how it relates to his/her academic plan of study. The course can only be taken for pass/fail credit, and it carries full-time status.

ENGR 8396 (3). DISSERTATION. 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.

ENGR 8696 (6). DISSERTATION. 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.

ENGR 8996 (9). DISSERTATION. 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.

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 students take.

Lyle engineering graduate course lectures are recorded "live" in one of the school's state-of-the-art telestudio 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 posted to a server at the Lyle School of Engineering within 24 hours of the on-campus course. Students can either view the lecture or download it to their computer and watch it within 48 hours to keep current with course content and requirements. Course handouts, syllabi and assignments are distributed by the department or via Blackboard. Graded homework is returned as directed by the professor. DE students may contact the instructor by email, telephone, fax or the U.S. Postal Service to ask questions and clarify points from the lecture. 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.

The Lyle School of Engineering offers DE students the opportunity to complete master's degrees in professional disciplines and traditional engineering disciplines. Each of the programs is interdisciplinary in content and flexible in approach. The programs are as follows:

GRE Not Normally Required for Master's Programs	*GRE Required for Master's Programs*
Datacenter Systems Engineering	Civil Engineering
Engineering Management	Computer Engineering
Information Engineering and Management	Computer Science
Manufacturing Systems Management	Environmental Engineering
Operations Research	Environmental Science
Security Engineering	Mechanical Engineering
Software Engineering	
Sustainability and Development	
Systems Engineering	
Telecommunications	

Note: The GRE graduate school entry exam is required for admission to all Ph.D. and DE programs. Students should see specific program sections for the GRE score requirements for various programs.

More information about the Lyle School's off-campus graduate programs can be obtained at www.smu.edu/Lyle/Graduate/ProspectiveStudents/DistanceEducation.

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 1) theoretical aspects of the relevant scientific principles, 2) solving the problems and understanding the details of the transfer and application of the technology and 3) 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 make 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.

Specific degree requirements for the Doctor of Engineering with a major in software engineering are found in the Computer Science and Engineering Department section of this catalog. Specific degree requirements for the Doctor of Engineering with a major in engineering management are found in the Engineering Management, Information and Systems Department section of this catalog.

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 supervisory committee (“Recommendation and Certification of Supervisory Committee”).
3. Basic coursework and preliminary counseling examination (if required by the student’s department).
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. The degrees must be from U.S. colleges or universities accredited by regional accrediting associations, or be international degrees equivalent to a U.S. bachelor's and/or master's degrees from colleges and universities of recognized standing. Each program has additional information on appropriate academic backgrounds required for admission into that program.

INITIAL ADVISING

Upon acceptance into the Doctor of Engineering program, the student is assigned an academic adviser. This adviser is a resident tenured or tenure-track faculty member in the student's home department. The selection of the adviser is an administrative decision that may not necessarily 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.

TOTAL ACADEMIC CREDIT

The total term credit hour requirement is 78 hours–66 hours of graduate coursework and 12 hours devoted to the praxis project. Postbaccalaureate coursework from other institutions and other graduate degrees may be applied toward the degree requisites subject to approval of the supervisory committee. There must be a minimum of 36 hours of graduate coursework and a minimum of 12 hours of praxis project work, none of which have been nor can be applied to any other 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. At least 18 of the 66 hours of coursework as well as the 12 hours devoted to the praxis must be taken in residence at SMU.

Recognition of Previous Postbaccalaureate 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 supervisory committee.

PRELIMINARY COUNSELING EXAMINATION

The preliminary counseling examination 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. 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 degree, 2) the student is disallowed from further study at SMU or 3) remedial action in areas of academic weakness is recommended.

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 several tests. Members of the supervisory committee administer the tests. The supervisory committee has full discretion as to the choice of material and the format and style of the written exam. Usually, the tests are designed to measure knowledge in an area of expertise of an individual supervisory committee member or on a topic from a course taught by that member. 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 tests and the availability of the supervisory committee members 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 have agreed on a schedule, the academic adviser issues a memorandum to all members of the supervisory 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 supervisory committee in time to be read prior to the oral presentation. This document outlines the responsibilities of the supervisory 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 supervisory 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 supervisory committee 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 supervisory committee.

THE DOCTORATE PRAXIS PROJECT

Composition of the Supervisory Committee

The purpose of the supervisory committee is to supervise the student's praxis project. The supervisory committee is made up of at least five members. At least four members of the committee must be resident tenured or tenure-track faculty members at SMU, three of whom must be members of the student's home department. The chair of the committee must be a member of the resident tenured or tenure-track faculty of the Lyle School and a member of the student's home department; however, a different committee member may act as the praxis director. Other mem-

bers of the supervisory committee may come from related areas such as engineering, business or economics. One committee member can be from outside the Lyle School of Engineering. The supervisory committee must be approved by the chair of the department and the associate dean, who is an ex officio member of the supervisory committee. The supervisory committee may be modified as the student progresses in the program. The supervisory committee may add members to include faculty members from other areas of specialization or cognizant members from industry who may contribute to the praxis.

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 1) outline the general technical scope of the project, 2) state the economic and technical relevance of the work and 3) 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 supervisory 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 supervisory 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 supervisory committee 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 Dissertation Publishing 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. Specific details about Ph.D. program requirements are found in the departmental sections of this catalog.

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 it 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 reexamination, subject to approval by the department chair and the associate dean. The right of reexamination 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 3.000 GPA or better (4.000 = *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 Dissertation Publishing 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.

DOCTOR OF PHILOSOPHY THROUGH MULTIDISCIPLINARY STUDIES

The Ph.D. 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.

CIVIL AND ENVIRONMENTAL ENGINEERING

Associate Professor Khaled F. Abdelghany, **Chair**

Professor: Paul S. Krueger (Mechanical Engineering). **Associate Professors:** Khaled F. Abdelghany, Usama S. El Shamy, David A. Willis (Mechanical Engineering). **Assistant Professors:** Andrew N. Quicksall, S. Sevinc Sengor, Brett Story. **Visiting Lecturer:** John H. Easton. **Adjunct Faculty:** Jane C. Ahrens, Arthur F. Beck, Samir Bougacha, Mark K. Boyd, Robert Casagrande, William S. Dahlstrom, Weiping Dai, H. Elizabeth del Monte, Leven T. Deputy, Roger O. Dickey, Theodore A. Dumas, Carl E. Edlund, Fawzi Elghadamsi, Andrew A. Felder, Edward Forest, Anwar Hirany, Sina Iman, James E. Langford, Donald L. Legg, Paul M. Martin, Mehedy Mashnad, Shannon K. McCall, Mofid Nakhaei, Jennifer A. O'Brien, Sally R. Pinon, Jon D. Rauscher, D. Blair Spitzberg, John L. Stanley, Bennett Stokes, Hung-Ming (Sue) Sung, Patricia A. Taylor, Kenneth T. Thomas, Philip K. Turner, Dan Wittliff, Scott P. Woodrow, Rumanda K. Young, Jessie Marshall Zarazaga. **Emeritus Professors:** Bijan Mohraz, Cecil H. Smith.

Graduate Programs

Graduate programs in the Department of Civil and Environmental 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.

Civil and environmental 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. Civil and environmental 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. The of Civil and Environmental Engineering Department offers the following graduate degrees and professional certificates:

Graduate Degrees

Master of Science in Civil Engineering
Master of Science in Environmental Engineering
Master of Science in Environmental Science
Master of Arts (Major in Sustainability and Development)
Doctor of Philosophy (Major in Civil and Environmental Engineering)

Professional Certificates

Adaptable Project Leadership
Air Quality Engineering
Construction and Asset Management
Enterprise Project Management
Environmental Management and Compliance
Infrastructure Systems Management
Occupational Health and Industrial Hygiene
Pollution Control and Prevention
Sustainability
Sustainable Development
Water Quality Management

Civil Engineering Program. 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. The civil engineering program prepares graduates for professional and academic careers through a focus in the following areas: 1) construction management, 2) geomechanics and foundations, 3) structural analysis and design, 4) water and wastewater treatment, 5) surface and groundwater quality management, and 6) transportation planning.

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) atmospheric systems and air-pollution control, 2) environmental and occupational health, 3) environmental chemistry and biology, 4) environmental systems and process modeling, 5) hazardous and waste materials management, 6) solid-waste management, 7) surface and groundwater quality management, and 8) wastewater management.

Contact Information. For more information about graduate programs in civil engineering, environmental engineering and environmental science, students should call 214-768-3894 or visit the Department of Civil and Environmental Engineering website at www.smu.edu/lyle/departments/cee. Additional contact and enrollment information is available from the Lyle School of Engineering at 214-768-1817 or www.smu.edu/Lyle/graduate.

Distance Learning. All M.S. degrees offered by the Department of Civil and Environmental 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 Civil Engineering

The M.S.C.E. 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 or via distance learning to accommodate the schedule of working professionals.

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 additional requirement: a B.S. in civil engineering or a closely related engineering discipline.

Degree Requirements

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

1. A total of 30 term credit hours, with a minimum graduate GPA of 3.000 on a 4.000 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 M.S. students will vary, depending on the student's undergraduate background and his or her desired area of specialization.

The following sample degree plans are for students who have a civil engineering undergraduate degree and want to specialize in structural engineering, geotechnical engineering or transportation systems management:

Sample Degree Plan: Geotechnical Engineering

Satisfactory completion of the core curriculum consisting of five courses (15 term credit hours):

CEE 7340 Introduction to Solid Mechanics
CEE 7361 Matrix Structural Analysis and Introduction to Finite Element Methods
CEE 7364 Introduction to Structural Dynamics
CEE 7373 Advanced Soil Mechanics
CEE 7375 Foundation Engineering

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:

CEE 7(0,1,2,3,6)96 Thesis
CEE 7362 Engineering Analysis With Numerical Methods
CEE 7387 Geotechnical Earthquake Engineering
CEE 7388 Groundwater and Seepage
CEE 7391 Special Projects (Topics in Geotechnical Engineering)

CEE 8340 Theory of Elasticity
CEE 8364 Finite Element Methods in Structural and Continuum Mechanics
CEE 8366 Basic Concepts of Structural Stability

Sample Degree Plan: Structural Engineering

Satisfactory completion of the core curriculum consisting of five courses (15 term credit hours):

CEE 7340 Introduction to Solid Mechanics
CEE 7361 Matrix Structural Analysis and Introduction to Finite Element Methods
CEE 7373 Prestressed Concrete
CEE 7375 Advanced Concrete Design
CEE 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:

CEE 7(0,1,2,3,6)96 Thesis
CEE 7364 Introduction to Structural Dynamics
CEE 7365 Introduction to Construction Management
CEE 7385 Advanced Soil Mechanics
CEE 7386 Foundation Engineering
CEE 7391 Special Projects (Topics in Structural Engineering)
CEE 8340 Theory of Elasticity
CEE 8364 Finite Element Methods in Structural and Continuum Mechanics
CEE 8366 Basic Concepts of Structural Stability
CEE 8368 Theory of Plate Behavior

Sample Degree Plan: Transportation Systems Management

Satisfactory completion of the core curriculum consisting of five courses (15 term credit hours):

CEE 7323 Project Management
CEE 7378 Transportation Planning and Traffic Engineering
CEE 7379 Highways Design and Safety
EMIS 7370 (STAT 5340) Probability and Statistics for Scientists and Engineers
EMIS 8360 Operations Research Models

Satisfactory completion of three specialization electives (15 term credit hours) chosen from the following courses:

CEE 7(0,1,2,3,6)96 Thesis
CEE 7331 Air Pollution Management and Engineering
CEE 7350 Introduction to Environmental Management Systems
CEE 7365 Introduction to Construction Management
CEE 7391 Special Projects (Topics in Transportation Engineering)
CEE 8378 Transportation Demand Analysis
CEE 8379 Analysis of Transportation Systems
CSE 7345 Advanced Java Programming
CSE 7365 (MATH 5315) Introduction to Numerical Analysis
CSE 8355 Graph Theory: Algorithms and Applications
EMIS 7340 Logistics Systems Engineering
EMIS 7377 (STAT 5377) Design and Analysis of Experiments

EMIS 8361 Economic Decision Analysis
EMIS 8371 Linear Programming
EMIS 8373 Integer Programming
EMIS 8374 Network Flows
STAT 6336 Statistical Analysis

Master of Science in Environmental Engineering

The M.S.Env.E. 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 an M.S. degree, applicants are required to satisfy these additional requirements:

1. A B.S. 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 an M.S. degree, candidates are required to satisfy these additional requirements: 30 term credit hours, with a minimum graduate GPA of 3.000 on a 4.000 scale. Additional articulation courses may be required for students without rigorous engineering undergraduate degrees.

Sample Degree Plan

Satisfactory completion of the core curriculum consisting of five courses (15 term credit hours):

CEE 7312 Risk Assessment and Health Effects
CEE 7313 Environmental Chemistry and Biology
CEE 7322 Biological Waste Treatment
CEE 7331 Air Pollution Management and Engineering
CEE 7354 Environmental Engineering Principles and Processes

Satisfactory completion of three Group I specialization electives (nine term credit hours) chosen from environmental engineering courses and related engineering disciplines, including

CEE 7321 Physical and Chemical Waste Treatment
CEE 7325 Disaster Management
CEE 7332 Groundwater Hydrology and Contaminants
CEE 7334 Fate and Transport of Contaminants
CEE 7335 Aerosol Mechanics
EMIS 7370 (STAT 5340) Probability and Statistics for Scientists and Engineers
ME 7336 Intermediate Fluid Dynamics

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

CEE 7(0,1,2,3,6)96 Thesis
CEE 7311 Environmental and Hazardous Waste Law
CEE 7314 Environmental Regulations and Compliance
CEE 7315 Integrated Waste Management
CEE 7323 Project Management
CEE 7350 Introduction to Environmental Management Systems
CEE 7351 Introduction to Environmental Toxicology
CEE 7352 Management of Radioactive Hazards
CEE 7353 Environmental Epidemiology
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

The M.S.E.S. 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 an M.S. degree, applicants are required to satisfy these additional requirements:

1. A B.S. 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 an M.S. degree, candidates are required to satisfy these additional requirements: 30 term credit hours, with a minimum graduate GPA of 3.000 on a 4.000 scale. Additional articulation courses may be required for students without an environmental, or closely related quantitative science or engineering, undergraduate degree.

Sample Degree Plan

Satisfactory completion of the required core curriculum consisting of five courses (15 term credit hours):

CEE 7312 Risk Assessment and Health Effects
CEE 7313 Environmental Chemistry and Biology
CEE 7322 Biological Waste Treatment
CEE 7331 Air Pollution Management and Engineering
CEE 7354 Environmental Engineering Principles and Processes

Satisfactory completion of three Group I specialization electives (nine term credit hours) chosen from environmental science and regulatory framework courses, including

BIOL/CHEM 5110 Biological Chemistry Laboratory
BIOL/CHEM 5310 Biological Chemistry: Macromolecular Structure and Function
BIOL 5311 Biological Chemistry: Metabolism
BIOL 5364 Endocrine Physiology
CEE 7311 Environmental and Hazardous Waste Law
CEE 7351 Introduction to Environmental Toxicology
CEE 7353 Environmental Epidemiology
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

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

CEE 7(0,1,2,3,6)96 Thesis
CEE 7314 Environmental Regulations and Compliance
CEE 7315 Integrated Waste Management

CEE 7321 Physical and Chemical Waste Treatment
CEE 7323 Project Management
CEE 7325 Disaster Management
CEE 7332 Groundwater Hydrology and Contamination
CEE 7334 Fate and Transport of Contaminants
CEE 7335 Aerosol Mechanics
CEE 7350 Introduction to Environmental Management Systems
CEE 7352 Management of Radioactive Hazards
CEE 7378 Transportation Planning and Traffic Engineering
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 Arts With a Major in Sustainability and Development

The M.A. with a major in sustainability and development offers a graduate-level degree to students looking for advanced education in the growing fields of sustainability and development. The program will produce graduates who will connect and contribute to the local community, deal with problems on the national and international stages, and increase the profile of the Bobby B. Lyle School of Engineering and Southern Methodist University as a whole. It will also be synergistic with and an important contributor to the success of the new Hunter and Stephanie Hunt Institute for Engineering and Humanity. All graduate courses are offered with evening class times and via distance learning to accommodate the busy schedules of working professionals.

Admission Requirements

Applicants holding a bachelor's degree from an institution of standard collegiate rank, recognized by the accrediting agencies in whose jurisdiction the college is located, may apply for admission to the M.A. with a major in sustainability and development. Graduates of colleges not fully recognized will be treated as special cases and required to produce evidence attesting to the quality of their programs. Any student whose bachelor's degree is not equivalent to the comparable baccalaureate degree from SMU may be required to take sufficient additional work to make up the deficiency. All applicants must have an overall grade point average of 3.000 (on a 4.000 scale).

Degree Requirements

Candidates are required to satisfy these requirements: 30 term credit hours, with a minimum graduate GPA of 3.000 on a 4.000 scale. All students must complete 15 hours of core requirements to include

CEE 7328 Introduction to Sustainability
CEE 7329 Methods and Technology for Sustainability
CEE 7330 Design for Sustainability
CEE 8326 Sustainable Development
CEE 8327 Policy Impacts on Sustainability

A depth component of an additional nine hours is required in one concentration:

Environmental Resources

CEE 7313 Environmental Chemistry and Biology
CEE 7331 Air Pollution Management and Engineering
CEE 7334 Fate and Transport of Contaminants
CEE 7353 Environmental Epidemiology
CEE 8328 Defining the Future of Global Sustainability
CEE 8329 Global Resource Use

Urban Development and Design

CEE 7363 Architectural and Structural Engineering
CEE 7370 Facility Planning
CEE 7378 Transportation Planning and Traffic Engineering
CEE 7384 Energy Management for Buildings
CEE 8325 The Sustainable Urban Plan
CEE 8330 Engineering Sustainability for the Future

Three term credit hours of breadth are required. This requirement will be satisfied by taking one course from another concentration. Students will receive depth in one track while building breadth in the overall field by taking one advanced course in another. Three term credit hours of capstone experience are required. This requirement may be satisfied by either of the following:

CEE 7391 Special Projects
CEE 7396 Master's Thesis

Students may enroll in a number of different sections of the special topics course CEE 7391. Different sections will be managed and prepared differently. It is the intent to provide seminar, research and site-based internship/service learning opportunities through the different sections. Students will have the option to choose which experience best matches their career path.

Doctor of Philosophy With a Major in Civil and Environmental Engineering

Admission Requirements

Applicants are required to satisfy these requirements:

1. An M.S. 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 3.000 on a 4.000 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 Ph.D. 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. Twenty-four term credit hours of dissertation.
4. Written and oral doctoral qualifying examinations.
5. A written dissertation.
6. Defense of the dissertation.

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. The following sample degree plans are for students who have been admitted to the Ph.D. program with an engineering M.S. degree and have an interest in structural engineering, air pollution control and atmospheric science, or water and wastewater engineering:

Sample Degree Plan: Geotechnical Engineering Track

Major Courses

CEE 7340 Introduction to Solid Mechanics
CEE 7361 Matrix Structural Analysis and Introduction to Finite Element Methods
CEE 7364 Introduction to Structural Dynamics
CEE 7373 Advanced Soil Mechanics
CEE 7387 Geotechnical Earthquake Engineering
CEE 7388 Groundwater and Seepage
CEE 8364 Finite Element Methods in Structural and Continuum Mechanics

Minor Courses

CEE 7391 Special Projects (Topics in Geotechnical Engineering)
CEE 7386 Foundation Engineering
Advanced courses in geological sciences, mathematics and statistical science

Alternative Major and Minor Courses

CEE 7362 Engineering Analysis With Numerical Methods
CEE 8340 Theory of Elasticity
CEE 8368 Theory of Plate Behavior

Sample Degree Plan: Structural Engineering Track

Major Courses

CEE 7340 Introduction to Solid Mechanics
CEE 7361 Matrix Structural Analysis and Introduction to Finite Element Methods
CEE 7364 Introduction to Structural Dynamics
CEE 7373 Prestressed Concrete
CEE 7375 Advanced Concrete Design
CEE 7377 Advanced Steel Design
CEE 8364 Finite Element Methods in Structural and Continuum Mechanics

Minor Courses

CEE 7385 Advanced Soil Mechanics
CEE 7386 Foundation Engineering
Advanced courses in geological sciences, mathematics and statistical science

Alternative Major and Minor Courses

CEE 7362 Engineering Analysis With Numerical Methods
CEE 8340 Theory of Elasticity
CEE 8368 Theory of Plate Behavior

Sample Degree Plan: Transportation Systems Management Track

Major Courses

CEE 7378 Transportation Planning and Traffic Engineering
CEE 8378 Transportation Demand Analysis
CEE 8379 Analysis of Transportation Systems
EMIS 7370 (STAT 5340) Probability and Statistics for Scientists and Engineers
EMIS 8360 Operations Research Models

Minor Courses

CSE 7345 Advanced Java Programming
EMIS 7377 (STAT 5377) Design and Analysis of Experiments
EMIS 8361 Economic Decision Analysis
EMIS 8371 Linear Programming
EMIS 8373 Integer Programming
EMIS 8374 Network Flows
STAT 6336 Statistical Analysis
Advanced courses in economic, mathematics and statistical science

Alternative Major and Minor Courses

CEE 7323 Project Management
CEE 7331 Air Pollution Management and Engineering
CEE 7379 Highways Design and Safety
CSE 7365 (MATH 5315) Introduction to Numerical Analysis
CSE 8355 Graph Theory: Algorithms and Applications
EMIS 7340 Logistics Systems Engineering

Sample Degree Plan: Air Pollution Control and Atmospheric Sciences Track

Major Courses

CEE 7312 Risk Assessment and Health Effects
CEE 7313 Environmental Chemistry and Biology
CEE 7331 Air Pollution Management and Engineering

CEE 7335 Aerosol Mechanics
CEE 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

CEE 7314 Environmental Regulations and Compliance
CEE 7321 Physical and Chemical Waste Treatment
CEE 7325 Disaster Management
CEE 7354 Environmental Engineering Principles and Processes
GEOL 5370 Global Change

Sample Degree Plan: Water and Wastewater Engineering Track

Major Courses

CEE 7313 Environmental Chemistry and Biology
CEE 7322 Biological Waste Treatment
CEE 7332 Groundwater Hydrology and Contamination
CEE 7334 Fate and Transport of Contaminants
CEE 7354 Environmental Engineering Principles and Processes
EMIS 7377 Design and Analysis of Experiments

Minor Courses

BIOL/CHEM 5311 Biological Chemistry: Metabolism
BIOL 5364 Endocrine Physiology
CEE 7312 Risk Assessment and Health Effects
CEE 7351 Introduction to Environmental Toxicology

Alternative Major and Minor Courses

CEE 7311 Environmental and Hazardous Waste Law
CEE 7315 Integrated Waste Management
CEE 7321 Physical and Chemical Waste Treatment
CEE 7325 Disaster Management
CEE 7350 Introduction to Environmental Management Systems
CEE 7353 Environmental Epidemiology

Professional Certificates

Professional certificates are comprised of subsets of courses from CEE 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 an M.S. 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. Nine term credit hours, with a minimum graduate GPA of 3.000 on a 4.000 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.

Core and Elective Courses

Adaptable Project Leadership

Core courses:

CEE 7365 Introduction to Construction Management
EMIS 7351 Enterprise Fundamentals

Plus one of the following electives:

CEE 7366 Introduction to Facilities Engineering Systems
EMIS 7320 Systems Engineering Leadership

Air Quality Engineering

Core courses:

CEE 7331 Air Pollution Management and Engineering
CEE 7335 Aerosol Mechanics

Plus one of the following electives:

CEE 7312 Risk Assessment and Health Effects
CEE 7352 Management of Radioactive Hazards
CEE 7353 Environmental Epidemiology

Construction and Asset Management

Core courses:

CEE 7323 Project Management
CEE 7365 Introduction to Construction Management

Plus one of the following electives:

CEE 7325 Disaster Management
CEE 7370 Facilities Planning

Enterprise Project Management

Core courses:

EMIS 7351 Enterprise Fundamentals
EMIS 7365 Program and Project Management

Plus one of the following electives:

CEE 7368 Facilities Contract Management
CEE 7371 Facility Financial and Asset Management

Environmental Management and Compliance

Core courses:

CEE 7314 Environmental Regulations and Compliance
CEE 7350 Introduction to Environmental Management Systems

Plus one of the following electives:

CEE 7311 Environmental and Hazardous Waste Law
CEE 7323 Project Management

Facilities Management

Any three of the following courses:

CEE 7363 Architectural and Structural Engineering
CEE 7366 Introduction to Facilities Engineering Systems
CEE 7370 Facility Planning
CEE 7371 Facility Financial and Asset Management
CEE 7384 Energy Management for Buildings

Global Sustainability

Core courses:

CEE 8328 Defining the Future of Global Sustainability
CEE 8329 Global Resource Use
CEE 8330 Engineering Sustainability for the Future

Hazardous and Waste Materials Management

Core courses:

CEE 7315 Integrated Waste Management
CEE 7323 Project Management

Plus one of the following electives:

CEE 7311 Environmental and Hazardous Waste Law
CEE 7312 Risk Assessment and Health Effects
CEE 7314 Environmental Regulations and Compliance

Infrastructure System Management

Core courses:

CEE 7350 Introduction to Environmental Management Systems
CEE 7366 Introduction to Facilities Engineering Systems

Plus one of the following electives:

CEE 7369 Electrical, Mechanical, and Piping Systems
EMIS 7360 Management of Information Technologies

Occupational Health and Industrial Hygiene

Any three of the following courses:

CEE 7312 Risk Assessment and Health Effects
CEE 7335 Aerosol Mechanics

CEE 7351 Introduction to Environmental Toxicology
CEE 7353 Environmental Epidemiology
CEE 7392 Special Topics: Fundamentals of Industrial Hygiene

Pollution Control and Prevention

Any three of the following courses:

CEE 7315 Integrated Waste Management
CEE 7322 Biological Waste Treatment
CEE 7331 Air Pollution Management and Engineering
CEE 7354 Environmental Engineering Principles and Processes

Sustainability

Core courses:

CEE 7328 Introduction to Sustainability
CEE 7329 Methods and Technology for Sustainability
CEE 7330 Design for Sustainability

Sustainable Development

Core courses:

CEE 8325 The Sustainable Urban Plan
CEE 8326 Sustainable Development
CEE 8327 Policy Impacts on Sustainability

Water Quality Management

Any three of the following courses:

CEE 7313 Environmental Chemistry and Biology
CEE 7322 Biological Waste Treatment
CEE 7332 Ground Water Hydrology and Contamination
CEE 7334 Fate and Transport of Contaminants
CEE 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 equip-

ment 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 (CEE)

Advanced Special Topics	
Seminar	7090
Special Projects	7(1–4)9(1–2)
Master's Thesis	7(0,1,2,3,6)96
Dissertation	8(0,1,3,6,9)96
Special Topics	8(1–9)9(0–4)

CEE 7049 (0). MASTER'S FULL-TIME STATUS.

CEE 7090 (0). CEE 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.

CEE 7096 (0). MASTER'S THESIS.

CEE 7191 (1). SPECIAL PROJECTS. Individual or group study of selected topics in environmental or civil engineering. Topics must be approved by the department chair and the instructor.

CEE 7192 (1). SPECIAL PROJECTS. Individual or group study of selected topics in environmental or civil engineering. Topics must be approved by the department chair and instructor.

CEE 7196 (1). MASTER'S THESIS.

CEE 7291 (2). SPECIAL PROJECTS. Individual or group study of selected topics in environmental or civil engineering. Topics must be approved by the department chair and instructor.

CEE 7292 (2). SPECIAL PROJECTS. Individual or group study of selected topics in environmental or civil engineering. Topics must be approved by the department chair and instructor.

CEE 7296 (2). MASTER'S THESIS.

CEE 7311 (3). ENVIRONMENTAL AND HAZARDOUS WASTE LAWS. Federal environmental laws, with emphasis on laws dealing with hazardous substances, such as CERCLA and RCRA; regulations and the regulatory framework; definitions and substantive requirements; roles of the states and the federal Environmental Protection Agency; compliance and enforcement; case studies.

CEE 7312/CEE 5312 (3). RISK ASSESSMENT AND HEALTH EFFECTS. Introduction to toxicology as it relates to environmental and health effects of hazardous materials; toxicology methodology; risk management factors including legal aspects; human health and ecological risk assessment and risk communication; emergency response; computer databases.

CEE 7313/CEE 5313 (3). 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; microbial ecosystems.

CEE 7314/CEE 5314 (3). 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 40 CFR regulations for water, air, and solid hazardous waste. Air, water, stormwater, 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.

CEE 7315/CEE 5315 (3). 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.

CEE 7317/CEE 5317 (3). ENVIRONMENTAL ORGANIC CHEMISTRY. This course will examine the fundamental processes that govern transformation 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 in 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.

CEE 7321/CEE 5321 (3). PHYSICAL AND CHEMICAL WASTE TREATMENT. Introduces waste minimization techniques and objectives, and thoroughly reviews chemical equilibrium and chemical reaction kinetics. 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.

CEE 7322/CEE 5322 (3). 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; in situ biotreatment and biotreatment of contaminated soils.

CEE 7323/CEE 5323 (3). PROJECT MANAGEMENT. Role of project officer; systems and techniques for planning, scheduling, monitoring, reporting, and completing environmental projects; total quality management; project team management, development of winning proposals; contract management and logistics; case study application of project management to all environmental media and programs; community relations, risk communication, crisis management, consensus building, media, and public policy.

CEE 7325/CEE 5325 (3). 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. National 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 the 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.

CEE 7327 (3). 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. Advance topics will include an introduction to chance-constrained optimization and basic decomposition approaches and their application to real-world problems.

CEE 7328 (3). 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. The inclusion of multiple guest lecturers will provide a series of multiple viewpoints and areas of specific expertise. *Prerequisite:* Graduate standing or permission of instructor.

CEE 7329/CEE 5329 (3). 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.

CEE 7330/CEE 5330 (3). 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 USGBC's LEED system will be specifically addressed. *Prerequisite:* Graduate standing or instructor permission.

CEE 7331 (3). 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, fate and 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.

CEE 7332/CEE 5332 (3). 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; groundwater quality management.

CEE 7333/CEE 5333 (3). LABORATORY METHODS IN ENVIRONMENTAL ENGINEERING. Provides students with hands-on, state-of-the-art experience with important experimental methods in environmental systems and with evaluation of the reliability and significance of parameter determinations. Covers instrumental and statistical methods used for characterization of water, air, and soil quality. Introduces treatability studies, including reactor dynamics. Provides 2 hours of lecture and 3 hours of laboratory component. *Prerequisite:* CEE 5313 or two terms of undergraduate chemistry.

CEE 7334/CEE 5334 (3). FATE AND TRANSPORT OF CONTAMINANTS. Development and application of fate and transport models for hazardous substances with focus on water-sediment, water-soil, and water-air interfaces; material balance principle; mass transport and transformation processes; modeling of lakes and reservoirs; stream modeling; general flow case; groundwater models; multiphase and integrated modeling approaches; case studies.

CEE 7335/CEE 5335 (3). 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 control equipment.

CEE 7340/ME 7340/CEE 5340/ME 5340 (3). INTRODUCTION TO SOLID MECHANICS. Three dimensional stress and strain, failure theories, introduction to two-dimensional elasticity, torsion of prismatic members, beams on elastic foundation, introduction to plates and shells, and energy methods. *Prerequisites:* CEE 2340 and MATH 2343.

CEE 7350/CEE 5350 (3). INTRODUCTION TO ENVIRONMENTAL MANAGEMENT SYSTEMS. An in-depth introduction to environmental management systems. Includes systems such as EMAS, Responsible Care, OHSAS 18000, ISO 14000, and the Texas EMS program. Takes a step by step look at the ISO 14001 standard from the policy statement to the management to review, and allow students to fully understand the plan-do-check-act approach of the system. Also introduces management systems auditing the requirements of a system auditor, and the certification process.

CEE 7351/CEE 5351 (3). 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 related to toxic substance exposure.

CEE 7352/CEE 5352 (3). 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:* CEE 5313.

CEE 7353/CEE 5353 (3). 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

CEE 7354/CEE 5354 (3). ENVIRONMENTAL ENGINEERING PRINCIPLES/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 application 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 unit processes to achieve specific treatment objectives.

CEE 7361/ME 7361/CEE 5361/ME 5361 (3). 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; computer solution of structural systems. *Prerequisite:* CEE 3350 or consent of instructor.

CEE 7362/CEE 5362 (3). 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.

CEE 7363/CEE 5363 (3). 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.

CEE 7364/ME 5364/ME 7364/CEE 5364 (3). INTRODUCTION TO STRUCTURAL DYNAMICS. Dynamic responses of structures and behavior of structural components to dynamic loads and foundation excitations; single and multiple degree-of-freedom systems response and its applications to analysis of framed structures; introduction to systems with distributed mass and flexibility. *Prerequisite:* MATH 2343.

CEE 7365/CEE 5365 (3). 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.

CEE 7366/CEE 5366 (3). INTRODUCTION TO FACILITIES ENGINEERING SYSTEMS. The interrelationships of fire protection, HVAC, electrical, plumbing, lighting, telecommunications, 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.

CEE 7367/CEE 5367 (3). TELECOMMUNICATIONS IN FACILITY PLANNING. A thorough description of telecommunications technology is presented. The course 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.

CEE 7368/CEE 5368 (3). FACILITIES CONTRACT MANAGEMENT. A critical foundation and understanding is provided of the terminology, arts and skills of contracts and contract negotiation, review and preparation, as well as insurance and risk management. 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.

CEE 7369/CEE 5369 (3). 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.

CEE 7370/CEE 5370 (3). 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.

CEE 7371/CEE 5371 (3). FACILITY FINANCIAL AND ASSET MANAGEMENT. Financial analysis and reporting, concepts and methods of accounting, budgeting, and evaluation of projects are examined. The role of facility managers in affecting corporate earnings and valua-

tions is presented. The management of the facility over its entire life-cycle extending from planning and budgeting to the management of its assets and construction projects is included.

CEE 7373/CEE 5373 (3). PRESTRESSED CONCRETE. Theory and application of prestressed concrete members, time-dependent deflections, and continuous prestressed beams. *Prerequisite:* CEE 4350 or equivalent.

CEE 7375/CEE 5375 (3). 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 foundation systems. *Prerequisite:* CEE 4350 or equivalent.

CEE 7377/ME 7377/CEE 5377/ME 5377 (3). 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:* CEE 4350 or equivalent.

CEE 7378/CEE 5378 (3). 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. *Prerequisites:* Basic principles of probability and statistics.

CEE 7379/CEE 5379 (3). HIGHWAYS DESIGN AND SAFETY. Provides an overview of the principals of highways design and traffic safety. Topics include highways functional classification, design control and criteria, driver performance, sight distance, horizontal and vertical alignments, cross section elements, design of freeways, intersections and interchanges, traffic safety, and environmental impact assessment.

CEE 7380/CEE 5380/ME 7380 (3). MANAGEMENT OF INDUSTRIAL AND MISSION-CRITICAL FACILITIES. Efficient industrial centers require balanced consideration with respect to facility design and function. Mission-critical component management and information technology systems are designed for exceptionally reliable performance and efficient operation. This course emphasizes the component systems that are designed to maintain a high level of function. Covers electrical and mechanical reliability, efficiency, readiness, robustness, and flexibility, and the management of the information technology systems. Explores strategies designed to eliminate costly downtimes, with emphasis on standby generators; automatic transfer switches; uninterruptable power supplies; fuel, fire, and battery systems; energy security; and environmental and cooling technologies. Presents the implementation of sustainable technology, green certifications, and alternative energy strategies that are compatible with the mission-critical requirements of the facility. Includes operational approaches to reduce energy requirements for power and cooling, mandated safety standards, and environmental codes. *Prerequisite:* Graduate standing or permission of instructor.

CEE 7381/CEE 5381/ME 7381 (3). SITE SELECTION FOR INDUSTRIAL AND MISSION-CRITICAL FACILITIES. Efficient industrial centers and facilities with mission-critical subsystems such as datacenters require balanced considerations with respect to facility design and site location. Site location plays an integral role in creating successful projects that especially support high reliability and promote sustainable design. While the important factors may vary from site to site, in any given instance a single factor can undermine the success of an otherwise excellent project. Ready availability and proper site selection that minimizes risk of disruption are particularly important factors for successful operation. Covers siting considerations, including power needs, electrical mix, weather patterns, building codes, proximity to the workforce and transportation, and other topics that bear on reliable operation. Emphasizes strategies of site selection to adequately safeguard hardware and mission-critical data. *Prerequisite:* Graduate standing or permission of instructor.

CEE 7383/ME 5383/CEE 5383/ME 7383 (3). HEATING, VENTILATING, AND AIR CONDITIONING. Examines the science and practice of controlling environmental conditions through the use of thermal process 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:* CEE 2331, CEE 2342, and ME 3332.

CEE 7384/CEE 5384 (3). ENERGY MANAGEMENT FOR BUILDINGS. Procedures to select energy saving options for buildings are examined with emphasis on practical aspects of the subjects. 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 are used to calculate energy consumption and compare energy features of proposed, audit-determined feasible changes to a building.

CEE 7385/CEE 5385 (3). 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:* CEE 4385.

CEE 7386/CEE 5386 (3). 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:* CEE 4385.

CEE 7387/CEE 5387 (3). GEOTECHNICAL EARTHQUAKE ENGINEERING. This course provides fundamental knowledge and practical application of soil dynamics and geotechnical earthquake engineering. This 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.

CEE 7388/CEE 5388 (3). GROUNDWATER AND SEEPAGE. Examines fundamental principles of flow through porous media and related engineering problems. Topics include the saturated seepage theory and flow nets; the unsaturated flow theory; suction-saturation and saturation-hydraulic conductivity relationships; the principle of effective stress; laboratory and field testing methods for determining material characteristics; and numerical models for flow-related engineering problems.

CEE 7391/CEE 5391 (3). 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.

CEE 7392/CEE 5392 (3). 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.

CEE 7396 (3). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in CEE 7396 and 7196.

CEE 7418/CEE 5418 (4). ENGINEERING MICROBIOLOGY. Aspects of microbiology that are particularly valuable to the practice of environmental engineering are examined. Specific areas of focus include enzyme and growth kinetics, cell structure and physiology, process of biotransformation, microbial/environmental interactions, and biogeochemical cycles. Elements of molecular biology and biotechnology are also presented as appropriate. The goal of this course is to provide a basic understanding and appreciation of microbial processes that are applicable in the field of environmental engineering.

CEE 7491 (4). SPECIAL PROJECTS. Individual or group study of selected topics in environmental or civil engineering. Topics must be approved by the department chair and instructor.

CEE 7492 (4). SPECIAL PROJECTS. Individual or group study of selected topics in environmental or civil engineering. Topics must be approved by the department chair and instructor.

CEE 7696 (6). MASTER'S THESIS.

CEE 8049 (0). PH.D. FULL-TIME STATUS.

CEE 8096 (0). DISSERTATION. No more than 15 term hours in a single term, and no more than 10 term hours in the summer terms. Registration in several sections may be needed to obtain the desired number of dissertation hours.

CEE 8190 (1). 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.

CEE 8191 (1). 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.

CEE 8192 (1). 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.

CEE 8193 (1). 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.

CEE 8194 (1). 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.

CEE 8196 (1). DISSERTATION. 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.

CEE 8290 (2). 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.

CEE 8291 (2). 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.

CEE 8292 (2). 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.

CEE 8293 (2). 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.

CEE 8294 (2). 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.

CEE 8325 (3). THE SUSTAINABLE URBAN PLAN. This course introduces the student to basic concepts in sustainable urban design and planning. Utilizing a group exercise, students are introduced to the factors shaping urban developments: financial projections, design concepts, marketability, public perception and municipal incentives and requirements. Additional information will be provided by lectures and discussions of the text, and guest speakers from the real estate community. The effects of urban design theory meeting economic reality, and the resulting options for sustainability will be thoroughly examined.

CEE 8326 (3). SUSTAINABLE DEVELOPMENT. A land development constructed for sustainability must work within multiple sets of existing regulations, and then go beyond business as usual, to address issues not commonly considered. This course will lead students through the combination of issues which lead toward sustainability within a project, including financial projections, legal issues and municipal regulations. The concept of a truly sustainable development will be examined and challenged.

CEE 8327 (3). POLICY IMPACTS ON SUSTAINABILITY. The idea of a truly sustainable society is either encouraged or negated by its policies. This course will examine policies at multiple levels to assess their impact on society's ability to become a sustainable one. Guest lecturers from the city, regional, and state level will be included, as well as examinations of policies at the national level from around the world.

CEE 8328 (3). DEFINING THE FUTURE OF GLOBAL SUSTAINABILITY. To discuss the long-term future of global sustainability, what that term includes must be defined. This course will examine the national and international drivers of change, both current and trends toward the future that can be identified.

CEE 8329 (3). GLOBAL RESOURCE USE. The globalization of the world's economy and politics has resulted in a globalization of resource use. Materials and services are routinely sourced from any spot in the world that can be competitive. The results of this situation are different in different hemispheres. This course examines the global distribution of energy use and energy production, and the resulting impact on air quality. Also considers goods production and transit, especially in the area of food production and availability. Other considerations will be ocean use and impact, the results of global climate change, and the availability of housing for all.

CEE 8330 (3). ENGINEERING SUSTAINABILITY FOR THE FUTURE. Solving the global challenges of the future will require innovative engineering of problems understood now and those not yet faced. This course will examine the current status of cutting edge technologies and analyze what issues will need to be addressed for the future survival of the planet.

CEE 8340/ME 8340 (3). 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 is covered. *Prerequisite:* CEE 7340 or equivalent.

CEE 8364/ME 8364 (3). 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:* CEE 7361.

CEE 8365 (3). CONSTRUCTION METHODS AND REHABILITATION. Basic construction methods and equipment used to rehabilitate existing buildings and structures are examined. Topics include: building maintenance, space improvement and building component alteration, installation of utilities including underground utility design. *Prerequisites:* CEE 7363, 7365.

CEE 8366/ME 8366 (3). 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:* CEE 7340 or permission of instructor.

CEE 8368/ME 8368 (3). THEORY OF PLATE BEHAVIOR. Analysis of flat plates subjected to normal loading, inplane loading, and thermal stresses. Plates of various shapes, thick plates, and anisotropic plates are analyzed for both small and large deflections. *Prerequisite:* CEE 7340 or permission of instructor.

CEE 8370 (3). FACILITY PROJECT MANAGEMENT. The principles and techniques of project management beginning with the conceptual phase, through coordination of design and construction, to project completion are presented. *Prerequisite:* CEE 7370.

CEE 8379 (3). ANALYSIS OF TRANSPORTATION SYSTEMS. An overview of techniques used to model and analyze transportation systems. Topics include 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.

CEE 8390 (3). 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.

CEE 8391 (3). SPECIAL TOPICS.

CEE 8392 (3). SPECIAL TOPICS. Individual or group study of selected topics in environmental engineering approved by the department chair, the instructor, and the academic dean.

CEE 8393 (3). 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.

CEE 8394 (3). 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.

CEE 8396 (3). DISSERTATION. 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.

CEE 8490 (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.

CEE 8491 (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.

CEE 8492 (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.

CEE 8493 (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.

CEE 8494 (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.

CEE 8590 (5). 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.

CEE 8591 (5). 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.

CEE 8592 (5). 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.

CEE 8593 (5). 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.

CEE 8594 (5). 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.

CEE 8690 (6). 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.

CEE 8691 (6). 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.

CEE 8692 (6). 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.

CEE 8693 (6). 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.

CEE 8694 (6). 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.

CEE 8696 (6). DISSERTATION. 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.

CEE 8790 (7). 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.

CEE 8791 (7). 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.

CEE 8792 (7). 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.

CEE 8793 (7). 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.

CEE 8794 (7). 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.

CEE 8890 (8). 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.

CEE 8891 (8). 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.

CEE 8892 (8). 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.

CEE 8893 (8). 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.

CEE 8894 (8). 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.

CEE 8990 (9). 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.

CEE 8991 (9). 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.

CEE 8992 (9). 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.

CEE 8993 (9). 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.

CEE 8994 (9). 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.

CEE 8996 (9). DISSERTATION. 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.

COMPUTER SCIENCE AND ENGINEERING

Professor Sukumaran V.S. Nair, **Chair**

Professors: Frederick R. Chang, Delores M. Etter (Electrical Engineering), David W. Matula, Sukumaran V.S. Nair, Stephen A. Szygenda, Mitchell A. Thornton, Jeff Tian. **Associate Professors:** James G. Dunham (Electrical Engineering), Daniel W. Engels, Ira Greenberg, Ping Gui (Electrical Engineering), LiGuo Huang. **Assistant Professors:** Jennifer A. Dworak, Eric C. Larson, Tyler W. Moore. **Senior Lecturer:** Frank P. Coyle. **Lecturers:** Donald E. Evans, Mark E. Fontenot, Theodore W. Manikas. **Adjunct Faculty:** Jeffrey D. Alcantara, Eduardo Blanco, Andrew W. Blanton, Timmothy Boyd, William A. Bralick, Jr., Ann E. Broihier, Ben A. Calloni, Hakki C. Cankaya, Christian P. Christensen, Darin DeRita, Maya El Dayeh, Aaron L. Estes, Dennis J. Frailey, Kenneth R. Howard, Bhanu Kapoor, Mohamed M.I. Khalil, Kamran Z. Khan, R. Mallik Kotamarti, Paul Krier, Lun Li, D. Kall Loper, Matthew R. McBride, Lee D. McFearin, Freeman L. Moore, Anurag Nagar, Padmaraj M.V. Nair, Robert S. Oshana, John J. Pfister, Leonid Popokh, Sohail Rafiqi, Mohamed O. Rayes, Luis G. Resendis, Gheorghe Spiride, Raymond E. Van Dyke. **Emeritus Professors:** Margaret H. Dunham, Richard V. Helgason.

Graduate Programs

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 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. The department offers the following graduate degrees and professional certificates:

Graduate Degrees

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)
Doctor of Philosophy (Major in Computer Engineering)
Doctor of Philosophy (Major in Computer Science)

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 3.000 (4.000 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 2240 Assembly Language Programming and Machine Organization
CSE 2341 Data Structures
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 3.000 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 3.000 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 toward 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. For the 8000-level courses, at least six credit hours must be CSE courses.

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 detailed 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. The electives may be selected from available graduate-level course offerings in the Lyle School of Engineering, subject to the residency and level requirements and adviser approval. Those who elect to take the 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 (two 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 (two 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 (two 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)

Electives may be selected from available graduate-level course offerings in the Lyle School of Engineering, subject to the residency and level requirements and adviser approval.

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 (CSE 8000 level) 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 With a 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 3.000 on a 4.000 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 3.000 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 3.000 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 toward 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. For the 8000-level courses, at least six credit hours must be CSE courses.

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. The electives may be selected from available graduate-level course offerings in the Lyle School of Engineering, subject to the residency and level requirements and adviser approval. 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 (two of the following)
- **CSE 7380** VLSI Algorithms
- **CSE 8350** Algorithms II
- **CSE 8351** Computer Arithmetic
- **CSE 8355** Graph Theory: Algorithms and Applications

Architecture (two 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 (two of the following)
- **CSE 7314** Software Testing and Quality Assurance
- **CSE 7319** Software Architecture and Design
- **CSE 7345** Advanced Application Programming
- **CSE 8313** Object-Oriented Analysis and Design Methodology
- **CSE 8316** User Interface Design

Data Science (two of the following)
- **CSE 7323** Mobile Applications for Sensing and Learning
- **CSE 7331** An Introduction to Data Mining and Related Topics
- **CSE 7337** Information Retrieval and Web Search
- **CSE 7338** Security Economics
- **CSE 7347** XML and the Enterprise
- **CSE 8331** Data Mining
- **CSE 8337** Information Storage and Retrieval

Security (two of the following)
- **CSE 7338** Security Economics
- **CSE 7339** Computer System Security
- **CSE 7349** Data and Network Security
- **CSE 7359** Software Security
- **CSE 7369** Hardware Security and Trojan Detection
- **CSE 8349** Advanced Network Security
- **CSE 8352 (EE 8372)** Cryptography and Data Security
- **CSE 8359** Advanced Software Security

Electives (12 hours)

Electives may be selected from available graduate-level course offerings in the Lyle School of Engineering, subject to the residency and level requirements and adviser approval.

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 With a 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 general graduate school entry exam 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
   CSE 7338 Security Economics
   CSE 7369 Hardware Security and Trojan Detection
   CSE 8317 Software Reliability and Safety
   CSE 8331 Data Mining
   CSE 8349 Advanced Network Security
   CSE 8352 (EE 8372) Cryptography and Data Security
   CSE 8353 Digital Forensics
   CSE 8356 Border and Transportation Security
   CSE 8359 Advanced Software Security
   CSE 8377 Fault Tolerance
   EMIS 7340 Logistics Systems Engineering
3. Satisfactory completion of three elective courses; these courses may be any of the available graduate-level course offerings in the Lyle School of Engineering.

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 one or more articulation courses. These articulation courses do 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 each articulation course to continue in the program.

Master of Science With a 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 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 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: 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:
   - **CSE 7111** Intellectual Property and Information Technology
   - **CSE 7340** Service-Oriented Computing
   - **CSE 7345** Advanced Application Programming
   - **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 With a 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 3.400 on a 4.000 scale in the student's junior and senior years.
2. Excellent academic performance in all completed coursework, with a GPA of at least 3.000 on a 4.000 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 general graduate school entry exam 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 language 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:

1. 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.
2. 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 dissertation director 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 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 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 21 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 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 3.000 on a 4.000 scale to graduate. If at any point a student's GPA drops below 3.000, the student is placed on academic probation. The student then has one term to raise his or her GPA to a minimum of 3.000 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 3.000.

Computer Science Seminar

All Ph.D. students who are receiving financial support from the department (such as teaching and research assistantships) must enroll in the seminar class CSE 8098 each term that the course is offered.

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 subfield 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.

Dissertation Director and Supervisory Committee

Before the student has completed 18 credit hours or two years of Ph.D. study (whichever comes first), he or she must identify a dissertation director 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 dissertation director must be one of the full-time tenure or tenure-track faculty members of the CSE Department. This requirement will be satisfied by successful completion and filing of the Recommendation and Certification of Appointment of Supervisory Committee form.

The dissertation director, 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 the CSE Department 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*+ (3.300) 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, dissertation director 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 dissertation director 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 dissertation director 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 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 director, 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 With a 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 3.400 on a 4.000 scale in the student's junior and senior years.
2. Excellent academic performance in all completed coursework, with a GPA of at least 3.000 on a 4.000 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 general graduate school entry exam 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 language 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:

1. 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.
2. 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 dissertation director 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 21 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 an 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 3.000 on a 4.000 scale to graduate. If at any point, a student's GPA drops below 3.000, the student is placed on academic probation. The student then has one term to raise his or her GPA to 3.000 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 3.000.

Computer Science Seminar

All Ph.D. students that are receiving financial support from the department (such as teaching and research assistantships) must enroll in the seminar class CSE 8098 each term that the course is offered.

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

Before the student has completed 18 credit hours or two years of Ph.D. study (whichever comes first), he or she must identify a dissertation director 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 dissertation director must be one of the full-time tenure or tenure-track faculty members of the CSE Department. This requirement will be satisfied by successful completion and filing of the Recommendation and Certification of Appointment of Supervisory Committee form.

The dissertation director, 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 the CSE Department 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*+ (3.300) 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, dissertation director 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 dissertation director 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 dissertation director is changed, the new dissertation director 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 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 director, 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 With a Major in Software Engineering

Students receiving a D.Engr. 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.Engr. 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 language 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.Engr. 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 that 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 7314 Software Testing and Quality Assurance
CSE 7315 Software Project Planning and Management
CSE 7316 Software Requirements
CSE 7319 Software Architecture and Design

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.Engr. with a major in software engineering will be determined by the student's supervisory committee. The plans will vary among students depending on their backgrounds and praxis topics. Sample degree plans cover basic degree requirements and technical specialties. 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 a D.Engr. with a major in software engineering candidates:

Security

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

Networks/Distributed Computing

CSE 7344 Computer Networks and Distributed Systems II
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 7331 An Introduction to Data Mining and Related Topics
CSE 7347 XML and the Enterprise
CSE 8330 Advanced Database Management Systems
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 Postbaccalaureate 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.Engr. 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 3.000 on a 4.000 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 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

Fundamentals courses plus the following:

CSE 7312 Software Systems Engineering
CSE 8313 Object-Oriented Analysis and Design

Certificate in Software Design Engineering

Fundamentals courses plus the following:

CSE 8313 Object-Oriented Analysis and Design

CSE 8316 User Interface Design

Certificate in Software Construction Engineering

Fundamentals courses plus the following:

CSE 8312 Software Generation and Maintenance

CSE 8313 Object-Oriented Analysis and Design

Certificate in Software Testing and Quality Engineering

Fundamentals courses plus the following:

CSE 8314 Software Metrics and Quality Engineering

CSE 8317 Software Reliability and Safety

Certificate in Distributed Computing Technologies

Fundamentals courses plus the following:

CSE 7347 XML and the Enterprise

Certificate in Software Management

Fundamentals courses plus 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)

CSE 7049 (0). MASTER'S FULL-TIME STATUS. Full-time status for students in the master's program.

CSE 7096 (0). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require registration in CSE 7396 and 7196.

CSE 7111/CSE 5111 (1). INTELLECTUAL PROPERTY AND INFORMATION TECHNOLOGY. Presents fundamentals in the nature, protection, and fair use of intellectual property. Patent, copyright, trademark, trade secret and antitrust principles are presented with an emphasis on the Internet, software, databases, and digital transmission technologies. The open source and creative commons alternatives for disseminating intellectual property are investigated. Examines the engineer's, scientist's, manager's, and creative artist's professional and ethical responsibilities and opportunities regarding intellectual property. Also investigates the rapid change in types and uses of intellectual property spawned by computers, digital media, e-commerce, and biotechnology. *Prerequisites:* Graduate standing and a general understanding of software and digital information systems.

CSE 7190 (1). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7191 (1). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7192 (1). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7193 (1). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7194 (1). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7196 (1). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require registration in CSE 7396 and 7196.

CSE 7290 (2). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7291 (2). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7292 (2). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7293 (2). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7294 (2). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7296 (2). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require registration in CSE 7396 and 7196.

CSE 7312 (3). SOFTWARE SYSTEMS ENGINEERING. The course 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. The course provides a framework for addressing systems engineering issues by focusing on the Software Engineering Institute's Systems Engineering Capability Maturity Model. Topics include deriving and allocating requirements, system and software architectures, integration, interface management, configuration management, quality, verification and validation, reliability, and risk.

CSE 7313/CSE 5313 (3). SOFTWARE CONFIGURATION MANAGEMENT. Successful software development and maintenance requires an understanding and application of many activities and functions throughout the software engineering process. One of the key areas is software configuration management. Students explore the principles and practices of the software configuration management function and mandatory role, including how CM is defined, planned, implemented, and measured over the life cycle of any development or maintenance project. Focuses on understanding specific roles of project team members and the tasks they plan and execute: managers who must support the CM efforts; project managers who must plan and design the CM system for their projects; those who implement the system; those who manage and administer the system; and the testers, engineers, and quality assurance personnel who are affected by the system.

CSE 7314 (3). SOFTWARE TESTING AND QUALITY ASSURANCE. The relationship of software testing to quality is examined with an emphasis on testing techniques and the role of testing in the validation of system requirements. Topics include 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 also are examined.

CSE 7315 (3). SOFTWARE PROJECT PLANNING AND MANAGEMENT. The issues associated with the successful management of a software development project are addressed. This includes

planning, scheduling, tracking, cost and size, estimating, risk management, configuration, management quality, engineering and process improvement. The course is centered on the concept of a software engineering process and includes discussion of life cycle models for software development. The SEI software process capability maturity model and other process standards are included.

CSE 7316 (3). SOFTWARE REQUIREMENTS. This course focuses on defining and specifying software requirements that can be used as the basis for designing and testing software. Topics include use-cases for describing system behavior, formal methods, specifying functional vs non-functional requirements and the relationship of requirements to software testing.

CSE 7317/CSE 5317 (3). LEADERSHIP FOR ARCHITECTING SOFTWARE SYSTEMS. Principles of leadership and software architecture in building large software systems or leading large teams. Involves a mix of personal assessment, reflection, and the development of leadership and influence skills and concepts unique to each student. Examines the process of developing large software systems in a constantly changing commercial environment.

CSE 7319/CSE 5319 (3). 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. The course explores the role of design in the software lifecycle including different approaches to design, design trade-offs and the use of design patterns in modeling object-oriented solutions. It also 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.

CSE 7320/CSE 5320 (3). ARTIFICIAL INTELLIGENCE. Introduces basic principles and current research topics in artificial intelligence. Includes the formal representation of real-world problems; the search of problem spaces for solutions; and the deduction of knowledge in terms of predicate logic, nonmonotonic reasoning, and fuzzy sets. Also, the 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 2341, 3342.

CSE 7323/CSE 5323 (3). MOBILE APPLICATIONS FOR SENSING AND LEARNING. Equips students with the practical skills necessary to develop mobile applications that take advantage of the myriad sensing and control capabilities of modern smartphones. Focuses on interfacing with phone hardware, efficient computing on the phone and in the cloud using virtualized servers, and efficient analysis of the peripheral sensor streams of today's smartphones. Students integrate real-time control and/or automation using a third-party hardware platform to interface with the mobile platform.

CSE 7330/CSE 5330 (3). FILE ORGANIZATION AND DATABASE MANAGEMENT. A survey of current database approaches and systems, and the principles of design and use of these systems. Covers query language design and implementation constraints, and applications of large databases. Includes a survey of file structures and access techniques. Also, the use of a relational database management system to implement a database design project. *Prerequisite:* CSE 2341.

CSE 7331/CSE 5331 (3). AN INTRODUCTION TO DATA MINING AND RELATED TOPICS. Introduces data mining topics, with an emphasis on understanding concepts through an applied, hands-on approach. Includes other related topics such as data warehousing and dimensional modeling. All material covered is reinforced through hands-on implementation exercises. *Prerequisite:* CSE 2341.

CSE 7337/CSE 5337 (3). INFORMATION RETRIEVAL AND WEB SEARCH. Introduces the field of information retrieval, with an emphasis on its application in Web search. Also introduces the basic concepts of stemming, tokenizing and inverted indices, text similarity metrics, and the vector-space model. Students study popular Web search engines and apply the concepts in several Java-based projects. *Prerequisite:* CSE 3353 or permission of instructor.

CSE 7338/CSE 5338 (3). SECURITY ECONOMICS. Introduces economics as a tool for understanding and managing information security. Reviews key information security challenges and technologies in order to reason about the topics economically. Students are introduced to techniques of analytic and empirical modeling. Economic concepts reviewed include rationality, markets, and information. Presents models and metrics of security investment, along with cost-benefit analysis techniques, and techniques for empirical investigation and measurement of

cybercrime. Security games are designed to capture the strategic interaction between defenders, as well as between attacker and defenders. Implications for public policy are discussed.

CSE 7339/CSE 5339 (3). 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.

CSE 7340/CSE 5340 (3). SERVICE-ORIENTED COMPUTING. Service-oriented computing is the computing paradigm that utilizes 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. Topics include Web architecture, HTTP, XML, SOAP, REST, BPEL, and developing interfaces that connect to independent services. The course will be of interest to those interested in creating and/or aggregating Web services and developing user interfaces for the display of those services. *Prerequisites:* Senior or graduate standing and programming experience.

CSE 7341/CSE 5341 (3). COMPILER CONSTRUCTION. Reviews programming language structures, loading, execution, and storage allocation; the compilation of simple expressions and statements; and the 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. Also, the use of a recursive high-level language to implement a complete compiler. *Prerequisites:* CSE 2341, 3342.

CSE 7342/CSE 5342 (3). CONCEPTS OF LANGUAGE THEORY AND THEIR APPLICATIONS. Introduction to formal languages and their relation to automata, and to denotational and operational semantics. Also, applications of formal semantics to the design and specification of programming languages and programming language processors, including computer architectures. Includes the predicate calculus, logic programming, and axiomatic semantics, as well as the application of axiomatic semantics to the verification of programs. *Prerequisite:* CSE 3342 or permission of the instructor.

CSE 7343/CSE 5343 (3). OPERATING SYSTEMS AND SYSTEM SOFTWARE. Theoretical and practical aspects of operating systems, including an overview of system software, time-sharing, and multiprogramming operating systems. Also, network operating systems and the Internet, virtual memory management, interprocess communication and synchronization, file organization, and case studies. *Prerequisite:* CSE 2341.

CSE 7344 (3). COMPUTER NETWORKS AND DISTRIBUTED SYSTEMS II. Introduction to network protocols, layered communication architecture, multimedia applications and protocols, quality of service, congestion control, optical networks, DWDM, network survivability and provisioning, wireless networks. There will be an interdisciplinary project requiring the use of currently available network design and simulation tools. *Prerequisite:* C- or better in CSE 4344.

CSE 7345/CSE 5345 (3). ADVANCED APPLICATION PROGRAMMING. Covers 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.

CSE 7346 (3). CLOUD COMPUTING. Explores architectures for cloud computing, and provides hands-on experience with virtualization technologies. Topics include cloud computing architectures such as infrastructure as a service, platform as a service, and software as a service. Covers programming models for cloud computing, the fundamentals of virtualization technologies that enable scalability, and an introduction to the security and energy efficiency challenges of cloud computing.

CSE 7347/CSE 5347 (3). 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. This course provides a detailed exami-

nation of XML as an enterprise technology. Focuses on APIs, interfaces, and standards that are driving this technology, including DTDs and XML Schema to structure XML data, XSLT to transform XML, XML protocols for distributed computing, and XML security initiatives. Students gain a broad understanding of XML and the technical issues and trade-offs among different alternatives for processing XML. *Prerequisites:* An understanding of object-oriented concepts and familiarity with Java and/or C++.

CSE 7348/CSE 5348 (3). 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 networking technologies. *Prerequisites:* CSE 7343 and C programming.

CSE 7349/CSE 5349 (3). DATA AND NETWORK SECURITY. Covers conventional and state-of-the-art methods for achieving data and network security. Private key and public key encryption approaches are discussed in detail, with coverage of popular algorithms such as DES, Blowfish, and RSA. In the network security area, the course covers authentication protocols, IP security, Web security, and system-level security. *Prerequisites:* CSE 7339 or equivalent, and instructor permission.

CSE 7350/CSE 5350 (3). ALGORITHM ENGINEERING. Covers algorithm design techniques; methods for evaluating algorithm efficiency; data structure specification and implementation; and applications to fundamental computational problems in sorting and selection, graphs and networks, scheduling and combinatorial optimization, computational geometry, and arithmetic and matrix computation. Also, introduction to parallel algorithms and to computational complexity and a survey of NP-complete problems. *Prerequisites:* CSE 2341, 3353 (for non-CSE graduate students: CSE 2341).

CSE 7356/EE 7356/CSE 5356/EE 5356 (3). VLSI DESIGN AND LABORATORY. Explores the design aspects involved in the realization of CMOS integrated circuits from device up to the register/subsystem level. Addresses major design methodologies with emphasis placed on structured, full-custom design. Also, the MOS device, CMOS inverter static characteristics, CMOS inverter dynamic characteristics, CMOS transistor fabrication technology, combination logic circuit, alternative static logic circuit, sequential logic circuit, dynamic logic circuit, propagation delay and interconnect, power dissipation and design for low power, memory device (DRAM/SRAM/ROM), ESD protection, packaging, testing, and VLSI design flow. Students use state-of-the-art CAD tools to verify designs and develop efficient circuit layouts. *Prerequisites:* C- or better in EE 2181, 2381, 3311.

CSE 7359/CSE 5359 (3). SOFTWARE SECURITY. As software is delivered across network and Web-based environments, security is critical to successful software deployment. This course 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 than at the network level. Students work with APIs for cryptography, digital signatures, and third-party certificate authorities. The course also explores issues related to XML and Web services security by examining standards and technologies for securing data and programs across collaborative networks. *Prerequisite:* C- or better in CSE 7339.

CSE 7365 (3). 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. Student use of the computer is emphasized. *Prerequisite:* Graduate standing or C- or higher in MATH 3315/CSE 3365 and in MATH 2343. Graduate students who have doubts about their preparedness for this course should consult the course instructor before enrolling.

CSE 7369/CSE 5369 (3). HARDWARE SECURITY AND TROJAN DETECTION. Introduces several contemporary topics in hardware security, with a particular emphasis on hardware Trojans. Other topics include physically unclonable functions, the problem of counterfeiting, security implications of design for testability in hardware, intellectual property protection, and secure coprocessors and smart cards.

CSE 7370 (3). 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.

CSE 7376 (3). 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 Network.

CSE 7380/CSE 5380 (3). VLSI ALGORITHMS. Introduces problems, algorithms, and optimization techniques used in the design of high-performance VLSI design. Emphasis on algorithms for partitioning, placement, floor planning, wire routing, and layout compaction.

CSE 7381/CSE 5381 (3). COMPUTER ARCHITECTURE. Introduces the state of the art in uniprocessor computer architecture, with a focus on the quantitative analysis and cost-performance trade-offs in instruction set, pipeline, and memory design. Topics include quantitative analysis of performance and hardware costs, instruction set design, pipeline, delayed branch, memory organization, and advanced instruction-level parallelism.

CSE 7382/CSE 5382 (3). COMPUTER GRAPHICS. Hardware and software components of computer graphics systems: display files, 2-D and 3-D transformations, clipping and windowing, perspective, hidden-line elimination and shaping, interactive graphics, and applications. *Prerequisite:* C- or better in CSE 3353.

CSE 7385/EE 7385/CSE 5385/EE 5385 (3). MICROCONTROLLER ARCHITECTURE AND INTERFACING. Emphasizes the design of microcontroller-based computer systems. Starts with the presentation of microcontroller architecture and continues with the design of computer systems with hierarchical memory, input-output peripherals, and industry-standard bus interfaces. 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 3381 and 3181.

CSE 7387 (3). 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:* C- or better in CSE 3381.

CSE 7390 (3). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7391 (3). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7392 (3). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7393 (3). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7394 (3). SPECIAL TOPICS. Individual or group study of selected topics in computer science. *Prerequisite:* Permission of instructor.

CSE 7396 (3). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require registration in CSE 7396 and 7196.

CSE 7696 (6). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Registration in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require registration in CSE 7396 and 7196.

CSE 8049 (0). PH.D. FULL-TIME STATUS. Full-time status for students in the Ph.D. program.

CSE 8091 (0). SPECIAL TOPICS.

CSE 8092 (0). SPECIAL TOPICS.

CSE 8095 (0). INDEPENDENT STUDY.

CSE 8096 (0). DISSERTATION. 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 CSE 8936 and 8996.

CSE 8098 (0). COMPUTER SCIENCE SEMINARS. The course consists of the seminars and colloquia given by the resident faculty and invited guests in various specialized as well as general topics in computer science.

CSE 8190 (1). SPECIAL TOPICS. Special and intensive study of selective topics in computer science aimed at encouraging students to follow recent developments through regular critical reading of the literature.

CSE 8191 (1). SPECIAL TOPICS. Individual or group study of selected advanced topics in computer science. *Prerequisite:* Permission of instructor.

CSE 8192 (1). SPECIAL TOPICS. Individual or group study of selected advanced topics in computer science. *Prerequisite:* Permission of instructor.

CSE 8193 (1). SPECIAL TOPICS. Special and intensive study of selective topics in computer science aimed at encouraging students to follow recent developments through regular critical reading of the literature.

CSE 8194 (1). 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.

CSE 8195 (1). 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.

CSE 8196 (1). DISSERTATION. 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 CSE 8936 and 8996.

CSE 8290 (2). SPECIAL TOPICS.

CSE 8291 (2). SPECIAL TOPICS. Individual or group study of selected advanced topics in computer science. *Prerequisite:* Permission of instructor.

CSE 8292 (2). GRADUATE SEMINAR. Individual or group study of selected advanced topics in computer science. *Prerequisite:* Permission of instructor.

CSE 8293 (2). SPECIAL TOPICS. Special and intensive study of selective topics in computer science aimed at encouraging students to follow recent developments through regular critical reading of the literature.

CSE 8294 (2). 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.

CSE 8295 (2). 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.

CSE 8296 (2). DISSERTATION. 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 CSE 8936 and 8996.

CSE 8312 (3). SOFTWARE GENERATION AND MAINTENANCE. Techniques for generating software and maintaining revisions to existing software will be examined. Topics include alternatives to coding, the use of program generators and very high-level languages, CASE tool, component reuse, 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.

CSE 8313 (3). OBJECT-ORIENTED ANALYSIS AND DESIGN. Object-oriented analysis and design is essential in developing high-quality object-oriented systems. The course will provide

an overview of object-oriented analysis and design by integrating the work of Booch, Rumbaugh, Jacobson, and Wirfs-Brock. Topics will include use-case analysis, responsibility-driven design, object modeling, entity-relationship modeling, and the design notation of the Unified Modeling Language. Additional topics will include object-oriented class libraries, object-oriented databases, and the Common Object Request Broker Architecture.

CSE 8314 (3). SOFTWARE METRICS AND QUALITY ENGINEERING. Techniques of software quality engineering with emphasis on the role of metrics are addressed. The approach is drawn from practical experience and uses many examples from industry. The psychological and behavioral aspects of quality and quality assurance are included. Metrics and quality are presented in relationship to the software process and software process maturity models. Selection of quality metrics is addressed in terms of the goal, question, or metric paradigm as well as various quality models. Methods of storing data for historical purposes, analyzing, and presenting data to others are included.

CSE 8315 (3). SOFTWARE ACQUISITION PRACTICES AND LEGAL AND ECONOMIC ISSUES. Issues relating to software procurement, contract law, specification and control of product processes are examined. Topics include 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 are studied in detail.

CSE 8316 (3). USER INTERFACE DESIGN. Design methodologies for user interfaces. Includes life cycles for UI development, human factors issues, prototyping, user analysis and evaluation, and design techniques. Students perform the analysis, design, and evaluation of a UI through two iterations.

CSE 8317 (3). SOFTWARE RELIABILITY AND SAFETY. In-depth study of techniques for ensuring software reliability and safety. Topics include software reliability engineering, software safety engineering, and recent developments in those areas. Reliability concepts applied to the software domain and safety concepts applied to computer-intensive systems will be discussed. 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 will be covered.

CSE 8320 (3). KNOWLEDGE-INTENSIVE PROBLEM-SOLVING. Focuses on higher-level artificial intelligence techniques for problem-solving guided by domain-specific knowledge. Topics include the use of planning systems, heuristic rule-based systems, model-based systems, learning networks, and semantic technologies. *Prerequisite:* CSE 7320.

CSE 8321 (3). 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 instructor.

CSE 8322 (3). NATURAL LANGUAGE PROCESSING AND INTERNET APPLICATIONS. This course 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, the course presents advanced material on lexical knowledge acquisition, natural language generation, machine translation, and parallel processing of natural language. *Prerequisite:* CSE 7320.

CSE 8325 (3). 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:* 2341, 3342.

CSE 8330 (3). DATABASE MANAGEMENT SYSTEMS. An extensive investigation of distributed databases and implementation issues. Included are design, data replication, concurrency control, and recovery. Implementation project included. *Prerequisite:* CSE 7330.

CSE 8331 (3). DATA MINING. Examines advanced data mining topics, including temporal mining. Web mining, spatial mining and text mining. Case studies and projects. *Prerequisite:* CSE 7331.

CSE 8337 (3). INFORMATION STORAGE AND 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:* CSE 7330.

CSE 8340 (3). ADVANCED TOPICS IN SOFTWARE ENGINEERING. In-depth study of specific topics in software engineering techniques, methodologies, and issues. Topics will change from term to term and will include advanced software reliability models, software development process models, advanced object-oriented design, and cleanroom software engineering.

CSE 8343 (3). ADVANCED OPERATING SYSTEMS. Theoretical and practical aspects of operating system design, implementation, system organization, and resource management. The emphasis is on distributed operating systems and advanced research issues. *Prerequisite:* CSE 7343.

CSE 8344 (3). 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.

CSE 8349 (3). 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.

CSE 8350 (3). 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, parallel algorithms. *Prerequisite:* CSE 7350.

CSE 8351 (3). COMPUTER ARITHMETIC. Number representation and algorithms for arithmetic unit design; redundant radix representation; highly parallel add, multiply, divide, and 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. *Prerequisite:* Knowledge of computer organization, data structures, and algorithms, as taught in CSE 2341.

CSE 8352/EE 8372 (3). 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:* EE/STAT/CSE 4340 or equivalent.

CSE 8353 (3). DIGITAL FORENSICS. Collection and analysis of evidence from electronic storage media or active systems. Methods to preserve, document, and present evidence in a court of law.

CSE 8355 (3). 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 instructor.

CSE 8356 (3). BORDER AND TRANSPORTATION SECURITY. Legal, political, and economic challenges of border and transportation security. Specific technologies include power solutions, wireless communications, sensor networks, sensing devices, screening devices, image acquisition, and image processing.

CSE 8357 (3). 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 is emphasized. Topics include database development to support design environments and representation, characteristics and design of synthesis, static analysis, and dynamic analysis tools. Human interface issues and CAD/CAE output formats are also covered. *Prerequisites:* EE 7356 or experience with design using CAD/CAE tools and programming skills.

CSE 8359 (3). ADVANCED SOFTWARE SECURITY. Advanced software security architectural patterns, software reverse engineering, and malware analysis. Advanced software exploitation techniques including shell coding, return-oriented programming, ASLR, and DEP bypassing.

Advanced Web application security and secure coding principles/practices. Security testing techniques, fuzzing, operating system security, and root kits. *Prerequisite:* CSE 5359, or 7359, or equivalent.

CSE 8375 (3). CODING THEORY AND APPLICATIONS. Information theory concepts: measure of information, mutual information, entropy. Algebra: groups, rings, finite fields, algebra of polynomials. Algebraic codes: linear codes, cyclic codes, BCH codes. Fire codes: encoding and decoding logic. Arithmetic codes: AN codes, separate adder, and checker. Applications to computer systems. *Prerequisites:* Elementary probability concepts and digital logic circuits.

CSE 8377 (3). FAULT-TOLERANT COMPUTING. 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.

CSE 8380 (3). PARALLEL AND DISTRIBUTED PROCESSING. Parallel and distributed processing is a fast-growing technology that permeates many aspects of computer science and engineering. This course emphasizes the strong interaction between parallel and distributed algorithms, architectures, and software. Topics include 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.

CSE 8381 (3). QUANTUM LOGIC AND COMPUTING. Survey of quantum logic and quantum computing from the viewpoint of a computer engineer or computer scientist. Focuses on issues in reversible computation, quantum information modeling, quantum logic circuit design, models of quantum computation, and quantum computer algorithms. Also surveys existing and emerging circuit models used to implement quantum logic circuits. Introduces principles of quantum mechanics as related to quantum computation. *Prerequisite:* CSE 7381 or 7385, or EE 7381 or 7385, or consent of instructor.

CSE 8383 (3). ADVANCED COMPUTER ARCHITECTURE. Advanced topics in computer architecture and parallel processing. *Prerequisite:* CSE 7381.

CSE 8386 (3). TESTING OF VLSI CIRCUITS. The objective of testing is to verify that the manufactured custom chips function correctly according to their specifications. 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.

CSE 8387 (3). 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. Includes both binary and multiple-valued logic systems. Previous exposure to an HDL is highly beneficial but is not a prerequisite. *Prerequisites:* Proficiency in using a modern programming language and CSE 7387 or equivalent.

CSE 8388 (3). 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 will cover the process of embedded computing system design under, mainly, cost, power, performance and several system-specific restrictions.

CSE 8389 (3). FOUNDATIONS OF FORMAL VERIFICATION AND VALIDATION. Detecting and correcting integrated circuit design errors before device fabrication is an increasingly complex and costly problem. This course surveys common approaches for formal methods used in industry and in other research environments. Emphasizes trade-offs 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. Introduces the application of formal methods in other areas. *Prerequisite:* Knowledge of programming languages, data structures, advanced digital logic design, and computer architecture, or consent of instructor.

CSE 8390 (3). SPECIAL TOPICS. Special and intensive study of selective topics in computer science aimed at encouraging students to follow recent developments through regular critical reading of the literature.

CSE 8391 (3). SPECIAL TOPICS. Individual or group study of selected advanced topics in computer science. *Prerequisite:* Permission of instructor.

CSE 8393 (3). SPECIAL TOPICS. Special and intensive study of selective topics in computer science aimed at encouraging students to follow recent developments through regular critical reading of the literature.

CSE 8394 (3). 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.

CSE 8395 (3). 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.

CSE 8396 (3). DISSERTATION. 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 CSE 8936 and 8996.

CSE 8490 (4). SPECIAL TOPICS. Special and intensive study of selective topics in computer science aimed at encouraging students to follow recent developments through regular critical reading of the literature.

CSE 8491 (4). SPECIAL TOPICS.

CSE 8492 (4). SPECIAL TOPICS.

CSE 8493 (4). SPECIAL TOPICS. Special and intensive study of selective topics in computer science aimed at encouraging students to follow recent developments through regular critical reading of the literature.

CSE 8494 (4). 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.

CSE 8495 (4). 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.

CSE 8496 (4). DISSERTATION.

CSE 8596 (5). DISSERTATION.

CSE 8693 (6). SPECIAL TOPICS. Special and intensive study of selective topics in computer science or computer engineering aimed at encouraging students to follow recent developments through regular critical reading of the literature.

CSE 8694 (6). SELECTED PROBLEMS. Independent investigation of topics in computer science or computer engineering approved by the department chair and by the major professor. *Prerequisite:* 12 term hours of graduate credit.

CSE 8695 (6). SELECTED PROBLEMS. Independent investigation of topics in computer science or computer engineering approved by the department chair and by the major professor. *Prerequisite:* 12 term hours of graduate credit.

CSE 8696 (6). DISSERTATION. 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 CSE 8936 and CSE 8996.

CSE 8996 (9). DISSERTATION. 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 CSE 8936 and 8996.

ELECTRICAL ENGINEERING

Professor Dinesh Rajan, **Chair**

Professors: Jerome K. Butler, Marc P. Christensen, Scott C. Douglas, Delores M. Etter, Gary A. Evans, W. Milton Gosney, Alireza Khotanzad, Sukumaran V.S. Nair (Computer Science and Engineering), Panos E. Papamichalis, Behrouz Peikari, Dinesh Rajan, Mitchell A. Thornton (Computer Science and Engineering). **Associate Professors:** Carlos E. Davila, James G. Dunham, Ping Gui, Choon S. Lee. **Assistant Professors:** Joseph D. Camp, Mohammad Khodayar. **Lecturer:** M. Scott Kingsley. **Adjunct Faculty:** Sudipto Chakraborty, Ahmed H. H'mimy, Hossam H. H'mimy, Kaushik Josiam, Shantanu Kangude, Clark D. Kinnaird, Khiem V. Le, Nhut Nguyen, Kaiser Saeed, Kamakshi Sridhar. **Emeritus Professors:** Kenneth L. Ashley, H. Charles Baker, Robert R. Fossum, Someshwar C. Gupta, Mandyam D. Srinath.

Graduate Programs

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. The department offers the following graduate degrees:

Graduate Degrees

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

Master of Science in Electrical Engineering

The 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, CAD, 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, ultrafast electronics and applications of the Scanning Tunneling microscope.

Admission Requirements

In addition to meeting the Lyle School of Engineering admission requirements for an M.S. degree, applicants are required to satisfy this additional requirement: a B.S. degree in electrical engineering or a closely related discipline.

Degree Requirements

In addition to meeting the Lyle School of Engineering degree requirements for an M.S. 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 3.000 prior to entering the program.
2. A total of 30 hours must be taken, of which 24 must be in EE. A minimum of four EE courses must be taken from one of the tracks listed below.

Communication and Networking

EE 7370 Communication and Information Systems
EE 7375 Random Processes in Engineering
EE 7376 Introduction to Computer Networks
EE 7377 Embedded Wireless Design Laboratory
EE 7378 Mobile Phone Embedded Design
EE 7379 Optimization in Wireless Networks
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 Topics in 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 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 7321 Semiconductor Devices and Circuits
EE 7340 Biomedical Instrumentation
EE 7356 VLSI Design and Lab
EE 7357 CAE Tools for Structured Digital Design
EE 7378 Mobile Phone Embedded Design
EE 7381 Digital Computer Design
EE 7385 Microprocessors in Digital Design
EE 8356 Advanced Topics in VLSI Design
EE 8382 Digital Signal Processing Architectures

Electromagnetics and Optics

EE 7330 Electromagnetics: Guided Waves
EE 7332 (MATH 6360) Electromagnetics: Radiation and Antennas
EE 7333 Antennas and Radiowave Propagation for Personal Communications
EE 7336 Introduction to Integrated Photonics
EE 8322 Semiconductor Lasers
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 Compound Semiconductor Devices and Processing
EE 7314 (ME 7314) Intro to Microelectromechanical Systems and Devices
EE 7321 Semiconductor Devices and Circuits
EE 8322 Semiconductors Lasers
EE 8355 Transistor Integrated Circuits

3. The remaining courses may be taken from different tracks. Of these, two can be from outside the EE department. Non-EE courses are restricted to EETS (with the **exception** of EETS 7301 or EETS 7302), ME, CSE, EMIS, CEE, math, physics, statistics, chemistry, biology, geological sciences or business.
4. At least two of the EE courses (six 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 With a 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, systems and networks. This program is intended for students interested in employment with a corporate telecommunications management group, equipment vendor, service provider, regulatory agency, or research or consulting firm. This program is offered both on- and off-campus via remote delivery systems. Students should see the Off-campus Distance Education section for more information regarding off-campus delivery systems.

Admission Requirements

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

1. A B.S. in one of the sciences, mathematics or computer science or in one of the engineering disciplines.
2. A 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 an M.S. 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 Network Protocols
EETS 8303 Switching and Routing

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

Advanced Electives

EETS 7305 Telecommunication Regulation
EETS 7316 Wireless, Cellular and Personal Telecommunications
EETS 7341 Fiber Optic Telecommunications
EETS 8305 Telecommunications Software Design
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 8321 Telecommunications Network Security
EETS 8322 Data Compression for Multimedia Applications
EETS 8331 Network Analysis, Architecture and Design
EETS 8332 Advanced Network Design
EETS 8337 Telecommunications Network Management
EETS 8341 Optical and DWDM Networks

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 several specialization options under the M.S. (major in telecommunications) program: engineering management, network design, software engineering and wireless communications.

Doctor of Philosophy With a Major in Electrical Engineering

Admission Requirements

1. An M.S. 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 3.000 on a 4.000 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 scheduled once each fall and spring term on dates to be announced by the committee. The exam must be taken on or before the third scheduled offering after the student begins the Ph.D. program. 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:

Circuits	Electromagnetic theory and optics
Communications	Solid-state devices and materials
Digital signal processing	Systems and control

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, the 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 it 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 reexamination.

Department Facilities

The Electrical Engineering Department is housed in the Jerry R. Junkins 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 356GB 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. This laboratory 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 milling machines, and a photolithic/chemical etching method is used to make more complex and large antennas. Fabricated antennas are characterized with a Hewlett-Packard 5810B network analyzer. Workstations are available for antenna design and theoretical computation. Radiation characteristics are measured at the Dallas-SMU Antenna Characterization Lab near the University of Texas at Dallas campus.

Biomedical Engineering Laboratory. This laboratory contains instrumentation for carrying out research in electrophysiology, psychophysics and medical ultrasound. Four Grass physiographs permit the measurement of electro-encephalograms as well as visual and auditory evoked brain potentials. The lab also contains a state-of-the-art dual Purkinje eye tracker and image stabilizer made by Fourward Tech-

nologies 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 be measured with a Physical Acoustics apparatus consisting of a water tank, radio frequency pulser/receiver and radio frequency data acquisition system. Several PCs are also available for instrumentation control and data acquisition.

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-by-8-foot acoustic window and an inert acoustic door facing the acoustic chamber. Up to 16 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 can be used in these activities to develop data sets for use in classroom experiments and laboratory projects for students to complete.

Wireless Systems Laboratory. The laboratory provides a multitier wireless network testbed that consists of multiple modes and frequency bands for research and instruction in lab-based courses on wireless communications and networking. The infrastructure in the lab includes 1) a GSM-based cellular network that provides a wide range of connectivity options at various data rates, 2) IEEE 802.11-based wireless networks and a high-performance channel emulator offering controlled, repeatable scenarios to isolate a vast array of variables experienced in outdoor testbeds, and 3) Bluetooth-based networks via multiple programmable mobile phone platforms that enable peer-to-peer communication and participatory sensing and context-aware applications. The lab also includes several programmable FPGA-based WARP systems to enable clean slate design at all layers of the protocol stack.

Semiconductor Processing Cleanroom. The 2,800 square-foot cleanroom, consisting of a 2,400 square-foot, Class 10,000 room and a Class 1,000 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, 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 profilometers. Other equipment includes a boron-trichloride reactive ion etcher, a chemical-assisted ion-beam etcher, and a four-tube diffusion furnace. The cleanroom is capable of processing silicon, compound semiconductors and piezo materials for microelectronic, photonic and nanotechnology devices.

Submicron Grating Laboratory. This laboratory is dedicated to holographic grating fabrication and has the capability of sub 10th-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 an 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:* 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.
- *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 is a fully equipped opto-mechanical and electrical prototyping facility, supporting the activities of faculty and graduate students in experimental and analytical tasks. The lab is ideally suited for the packaging, integration and testing of devices, modules and prototypes of optical systems. It has three large vibration isolated tables, a variety of visible and infrared lasers, single element 1-D and 2-D detector arrays, and a large complement of optical and opto-mechanical components and mounting devices. In addition, the laboratory has extensive data acquisition and analysis equipment, including an IEEE 1394 FireWire-capable image capture and processing workstation, specifically designed to evaluate the electrical and optical characteristics of smart pixel devices and FSOI fiber-optic modules. Support electronics hardware includes various test instrumentation, such as arbitrary waveform generators, and a variety of CAD tools for optical and electronic design, including optical ray trace and finite difference time domain software.

Electrical Engineering 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

EE 7049 (0). MASTER'S FULL-TIME STATUS.

EE 7090 (0). GRADUATE SEMINAR.

EE 7096 (0). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours.

EE 7190 (1). SPECIAL TOPICS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in EE 7396 and 7196.

EE 7196 (1). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in EE 7396 and 7196.

EE 7290 (2). SPECIAL TOPICS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in EE 7396 and 7196.

EE 7296 (2). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in EE 7396 and 7196.

EE 7301 (3). POWER MANAGEMENT FOR INDUSTRIAL AND MISSION CRITICAL FACILITIES. Overview of the issues in power management (maximize uptime, minimize costs, reduce risk, improve reliability, and increase operation efficiency) in a data center or other mission critical facility. Topics include DC and AC power concepts (three-phase power, etc.), tier level rankings and their impact on design and cost, redundancy and fault tolerant integration to avoid single points of failure, power quality indices and methods to improve power quality, introduction to AC and DC distribution systems in data centers, design and installation of LED lighting systems, UPS, battery, generators, uninterrupted operating capability in power distribution, air conditioning and air distribution architecture, energy efficiency in data centers, fault protection and system grounding, system security (fire detection systems, pre-action sprinkler systems, dry suppression systems, etc.), comprehending IT hardware refresh cycles, and standardization in energy infrastructure.

EE 7310 (3). INTRODUCTION TO SEMICONDUCTORS. The basic principles in physics and chemistry of semiconductors that have direct applications on device operation and fabrication are studied. Topics include basic semiconductor properties, elements of quantum mechanics, energy band theory, equilibrium carrier statistics, carrier transport, and generation-recombination processes. These physical principles are applied to semiconductor devices. Devices studied include metal-semiconductor junctions, p-n junctions, LEDs, semiconductor lasers, bipolar junction transistors, field-effect transistors, and integrated circuits. The emphasis will be on obtaining the governing equations of device operation based on physical principles.

EE 7312 (3). COMPOUND SEMICONDUCTOR DEVICES AND PROCESSING. This is a laboratory-oriented elective course for upper-level undergraduates and graduate students providing in-depth coverage of processing of InP and GaAs based devices 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, metallization, 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.

EE 7313 (3). SOLAR CELLS AND APPLICATIONS. This laboratory-oriented course explores the sun's energy as a source of electrical power and the working principles of silicon and III-V solar cells. Covers characteristics of the sun, semiconductor properties, p-n junctions, solar cell fabrication, and photovoltaic system design. Students fabricate and test silicon solar cells in the SMU cleanroom. Lectures and class discussions explain the basic operation of p-n junction diodes and solar cells along with the basics of device processing, including photolithography, oxidation, diffusion, ion implantation, metallization, and etching. *Prerequisite:* EE 3311 or permission of instructor.

EE 7314 (3). INTRODUCTION TO MICROELECTROMECHANICAL SYSTEMS. Develops the basics for microelectromechanical devices and systems (including microactuators, microsensors, and micromotors), principles of operation, different micromaching techniques (surface and bulk micromaching), IC-derived microfabrication techniques, and thin-film technologies as they apply to MEMS.

EE 7318 (3). INTRODUCTION TO MEMS.

EE 7321 (3). 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 multiple stage 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, 3322.

EE 7322/EE 3311 (3). SEMICONDUCTOR DEVICES AND FABRICATION. This laboratory-oriented, elective course introduces the working principles of semiconductor devices and includes the fabricating and testing of silicon MOSFET transistors in the SMU cleanroom. Lectures and class discussions (about 22 hours) explain the basic operation of p n junction diodes, bipolar junction transistors, heterojunction bipolar transistors, field effect transistors, high electron mobility transistors, solar cells, detectors, light-emitting diodes, and semiconductor lasers. Class lectures (about 20 hours) cover the basics of device processing, including photolithography, oxidation, diffusion, ion-implantation, metallization, and etching. Weekly laboratory reports and a final project report describing the fabrication and testing of devices account for a major portion of the course grade. Students lead weekly discussions of the previous week's laboratory experiences and homework problems. An optional field trip to a local semiconductor related company is possible. Credit will not be given for both EE 7322 and EE 3311.

EE 7330 (3). 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.

EE 7332 (3). ELECTROMAGNETICS: RADIATION AND ANTENNAS. Polarization, reflection, refraction, and diffraction of EM waves. Dipole, loop, and slot and reflector antennas. Array analysis and synthesis. Self and mutual impedance. Radiation resistance. *Prerequisite:* EE 3330.

EE 7333 (3). ANTENNAS AND RADIOWAVE PROPAGATION FOR PERSONAL COMMUNICATIONS. This course is concerned with three important aspects of telecommunications: fixed site antennas, radiowave propagation, and small antennas proximate to the body. The topics include 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.

EE 7335 (3). 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 7330.

EE 7336 (3). INTRODUCTION TO INTEGRATED PHOTONICS. This course is directed at the issues of integrated photonics. Four major areas are covered: 1) fundamental principles of electromagnetic theory; 2) waveguides; 3) simulation of waveguide modes, and 4) photonic structures. The emphasis is slightly heavier into optical waveguides and numerical simulation techniques because advances in optical communications will be based on nanostructure waveguides coupled with new materials. Topics include: Maxwell's equations; slab, step index, rectangular and graded index wave guides; 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, 3330 or permission of instructor.

EE 7340 (3). BIOMEDICAL INSTRUMENTATION. Application of engineering principles to solving problems encountered in biomedical research. Topics include transducer principles, electrophysiology, and cardiopulmonary measurement systems.

EE 7345 (3). MEDICAL SIGNAL ANALYSIS. This course looks at the analysis of discrete-time medical signals and images. Topics include 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. Research element required for course project.

EE 7356/CSE 7356/CSE 5356/EE 5356 (3). VLSI DESIGN AND LAB. Explores the design aspects involved in the realization of CMOS integrated circuits from device up to the register/subsystem level. Addresses major design methodologies with emphasis placed on structured, full-custom design. Also, the MOS device, CMOS inverter static characteristics, CMOS inverter dynamic characteristics, CMOS transistor fabrication technology, combination logic circuit, alternative static logic circuit, sequential logic circuit, dynamic logic circuit, propagation delay and interconnect, power dissipation and design for low power, memory device (DRAM/SRAM/ROM), ESD protection, packaging, testing, and VLSI design flow. Students use state-of-the art CAD tools to verify designs and develop efficient circuit layouts. *Prerequisites:* C- or better in EE 2181, 2381, 3311.

EE 7357 (3). CAE TOOLS FOR STRUCTURED DIGITAL DESIGN. This course concentrates on 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. Structured modeling and design will be emphasized. Design case studies include a pipelined processor, cache memory, UART, and a floppy disk controller. *Prerequisite:* EE 2381 or permission of instructor.

EE 7360 (3). ANALOG AND DIGITAL CONTROL SYSTEMS. Feedback control of linear continuous systems in the time domain and frequency domain. Topics include plant representation, frequency response, stability, root locus, linear state variable feedback, and design of compensators. *Prerequisite:* EE 3372.

EE 7362 (3). 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.

EE 7370 (3). 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 3372.

EE 7371 (3). ANALOG AND DIGITAL FILTER DESIGN. Approximation and analog design of Butterworth, Chebyshev, 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.

EE 7372 (3). TOPICS IN DIGITAL SIGNAL PROCESSING. This course is intended to provide an extended coverage of processing of discrete-time signals. Discrete-time signals and the analysis of systems in both the time and frequency domains are reviewed. Other topics covered

will include multi-rate signal processing, digital filter structures, filter design and power spectral estimation. *Prerequisite:* C- or better in EE 3372.

EE 7373 (3). DSP PROGRAMMING LABORATORY. This course looks at applications of digital signal processor technology based on the Texas Instruments TMS320C50 DSP. The course looks at DSP device architecture, assembly language, use of DSP development tools, design of FIR and IIR filters, and real-time spectrum analysis with the FFT.

EE 7374 (3). DIGITAL IMAGE PROCESSING. Provides an introduction to the basic concepts and techniques of digital image processing. Topics covered will include characterization and representation of images, image enhancement, image restoration, image analysis, image coding, and reconstruction. *Prerequisite:* EE 7372.

EE 7375 (3). RANDOM PROCESSES IN ENGINEERING. An introduction to probability and stochastic processes as used in communication and control. Topics include 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:* Permission of instructor.

EE 7376 (3). INTRODUCTION TO COMPUTER NETWORKS. This is an introductory course that surveys basic topics in communication networks with an emphasis on layered protocols and their design. Topics include 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, Internet protocol, TCP, and ATM. Assignments may include lab exercises involving computer simulations.

EE 7377 (3). EMBEDDED WIRELESS DESIGN LAB. A wide variety of real-world experiences in wireless communications and networking using FPGAs equipped with embedded microprocessors. Covers basic wireless concepts of scheduled and random access as well as modulation and power control via labs that enable implementation of cellular and 802.11-based wireless protocols such as TDMA, Aloha, CSMA, and CSMA/CA. Also, broader topics that range from embedded programming, interrupt-driven operation, and FPGA-based design are covered in some depth. In a course project, student teams design novel wireless protocols and carry out experiments to measure the performance. *Prerequisite:* C- or better in EE 3360 or equivalent, or permission of instructor.

EE 7378 (3). MOBILE PHONE EMBEDDED DESIGN. In this course, students learn how to develop embedded software for the most widely used smartphone platforms with an emphasis on wireless and sensing applications. Topics include user interface design such as multi-touch and basic HCI design tenets, storing and fetching data with local networked systems and databases, localization via GPS and wireless signal triangulation, sensing environmental and user characteristics, networking with various wireless protocols, graphics rendering, multimedia streaming, and designing for performance such as controlling memory leaks, object allocation, and multi-threading. Content from the course draws from various fields including wireless communications and networking, embedded programming, and computer architecture.

EE 7379 (3). OPTIMIZATION IN WIRELESS NETWORKS. Covers a wide variety of optimization problems in the design and operation of wireless networks. Introduces basic linear programming and integer linear programming concepts and explains these concepts using examples from wired and wireless networks. Also, the basic structure and design of various wireless networks, including cellular networks (such as GSM) and wireless LANs (e.g., those based on 802.11g/n). *Prerequisite:* EE 2170 or equivalent, or permission of instructor.

EE 7381 (3). 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. *Prerequisites:* EE 2181, 2381.

EE 7385/CSE 7385/CSE 5385/EE 5385 (3). MICROCONTROLLER ARCHITECTURE AND INTERFACING. Emphasizes the design and interfacing of microprocessor computer systems. Topics cover processor architecture and interfacing, memory structure and interfacing, bus systems, support chips, tools for hardware design, analysis, simulation, implementation, and debugging. The theoretical part of the course is complemented by a laboratory in which students get practical experience in designing and analyzing interfaces to processors, memories, and peripherals. *Prerequisites:* CSE 3381, or EE 3181 and 3381.

EE 7387 (3). 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. *Prerequisites:* EE 2381, CSE 3381.

EE 7390 (3). SPECIAL TOPICS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in EE 7396 and 7196.

EE 7391 (3). SPECIAL TOPICS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in EE 7396 and 7196.

EE 7392 (3). SPECIAL TOPICS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in EE 7396 and 7196.

EE 7393 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 7395 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 7396 (3). MASTER'S THESIS. This special topics course must have a section number associated with a faculty member.

EE 7490 (4). SPECIAL TOPICS.

EE 7696 (6). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours.

EE 8049 (0). PH.D. FULL-TIME STATUS.

EE 8095 (0). INDEPENDENT STUDY.

EE 8096 (0). DISSERTATION.

EE 8190 (1). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8191 (1). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8192 (1). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8193 (1). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8194 (1). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8195 (1). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8196 (1). DISSERTATION. This special topics course must have a section number associated with a faculty member.

EE 8290 (2). SPECIAL TOPIC. This special topics course must have a section number associated with a faculty member.

EE 8291 (2). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8292 (2). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8293 (2). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8294 (2). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8295 (2). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8296 (2). DISSERTATION. This special topics course must have a section number associated with a faculty member.

EE 8310 (3). ELECTRONIC PROCESSES. Study of atomic, molecular, and crystal structures; electron motion in crystals; carrier statistics; band theory; electronic transport properties; and scattering and recombination mechanisms in metals and semiconductors.

EE 8322 (3). SEMICONDUCTOR OPTIC SYSTEMS. A study of semiconductor lasers and light-emitting diode optical sources, semiconductor optical detectors, receiver noise, optical fiber waveguides and their transmission characteristics, and optical fiber systems.

EE 8325 (3). INFRARED SYSTEMS ENGINEERING. This course develops the basic physical and operating principles of optical detectors. This course focuses on infrared detectors. The topics include geometric optics, blackbody radiation, radiometry, photon detection mechanisms, thermal detection mechanisms, probability and statistics of optical detection, noise in optical detectors, figures of merit, photovoltaic detectors, photoconductive detectors, bolometers, pyroelectric detectors, Schottky diode detectors, and quantum well detectors. *Prerequisites:* EE 3311 and EE 3330, or optics.

EE 8331 (3). MICROWAVE ELECTRONICS. A study of microwave circuit design covering amplifiers, mixers, and oscillators using s-parameters. Topics include 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. *Prerequisites:* EE 3330, 7330, or 7332.

EE 8332 (3). NUMERICAL TECHNIQUES IN ELECTROMAGNETICS. This course introduces various numerical methods in electromagnetics, with emphasis on practical applications. The numerical methods include 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 instructor.

EE 8333 (3). ADVANCED ELECTROMAGNETIC THEORY. The course offers the advanced level of electromagnetic theory beyond EE 5330. Topics include various electromagnetic theories and principles. Green's functions, and perturbational and variational techniques. *Prerequisite:* EE 7330.

EE 8355 (3). TRANSISTOR INTEGRATED CIRCUITS. An introduction to CMOS, BJT, and BiCMOS analog integrated circuits. Topics include development of detailed, physically based device model 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 is 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.

EE 8356 (3). ADVANCED TOPICS IN VLSI DESIGN. This is a seminar oriented course aiming at advanced issues in VLSI design. The instructor will make a short introduction for each topic covered. The students are then required to make a presentation on the details. The term project is required for each student. The grade will be based on both presentation and project. *Prerequisite:* EE 7356 or permission of instructor.

EE 8361 (3). OPTIMAL CONTROL. Topics related to deterministic system control include applications of the variational calculus using Hamiltonian methods, optimization with control variable constraints, maximum principle, linear quadratic problem, Ricatti equation and principle of optimality. Optimal stochastic control discusses point estimation, state estimation, Kalman filter, linear quadratic Gaussian problem, and separation principle. *Prerequisites:* EE 7360, 7375, and 8360.

EE 8364 (3). STATISTICAL PATTERN RECOGNITION. Introduction to various parametric and nonparametric statistical approaches to automatic classification of a set of processes. Topics include: 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.

EE 8365 (3). ADAPTIVE FILTERS. A detailed treatment of the theory and application of adaptive filter processing. Topics include linear prediction, stochastic gradient (LMS) adaptive transversal filters, recursive least-squares adaptive transversal filters, lattice filters, and fast RLS algorithms. Applications to be discussed include adaptive equalization, echo cancellation, system identification, beamforming, speech coding, and spectral estimation. *Prerequisites:* EE 7372, 7375 or permission of instructor.

EE 8367 (3). NONLINEAR CONTROL. This course introduces the student to methods of the control of nonlinear systems. The course reviews phase plane analysis of nonlinear systems, Lyapunov theory, nonlinear stability and describing function analysis. Advance control techniques include feedback linearization, sliding control, and adaptive control. Special emphasis will be placed on the application of the developed concepts to the robust regulation of the response of nonlinear systems. *Prerequisite:* EE 7362.

EE 8368 (3). SIGNAL PROCESSING FOR WIRELESS COMMUNICATIONS. This course focuses on signal processing used in wireless communications. Emphasis is given to channel equalization, which can be considered a form of temporal signal processing, spatial array processing, and space-time processing. Specific topics include classical and blind channel equalization, Fourier, parametric, and subspaced-based direction finding methods for smart antennas, and space-time signal processing. *Prerequisite:* EE 7372.

EE 8370 (3). ANALOG AND DIGITAL COMMUNICATIONS. Review of stochastic processes. Detection of waveform in noise. Matched filters and correlation receivers. Parameter and waveform estimation. Wiener and Kalman filters. Optimal receivers for analog and digital communication systems. *Prerequisite:* EE 7375.

EE 8371 (3). INFORMATION THEORY.

EE 8372/CSE 8352 (3). 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:* EE/STAT/CSE 4340 or equivalent.

EE 8373 (3). DIGITAL SPEECH PROCESSING. A detailed treatment of theory and application of digital speech processing. The course provides a fundamental knowledge of speech signals and speech processing techniques. Topics include digital speech coding, speech synthesis, speech recognition, and speech verification. *Prerequisite:* EE 7372.

EE 8374 (3). FUNDAMENTALS OF COMPUTER VISION. Introduction to the basic concepts and various techniques for computer analysis, interpretation, and recognition of pictorial data. Topics include binary image analysis, edge and curve detection, image segmentation, shape and texture representation and recognition, morphological methods, and stereo vision. *Prerequisites:* Familiarity with basic concepts in signal processing and probability theory.

EE 8375 (3). ERROR CONTROL CODING. Topics include information theory, algebraic and arithmetic codes, and applications to computer systems. *Prerequisites:* Elementary probability concepts and digital logic circuits.

EE 8376 (3). 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.

EE 8377 (3). ADVANCED DIGITAL COMMUNICATIONS. Quantization, binary, and block encoding signals and systems, convolution coding, fading, diversity, spread-spectrum communications, mobile radio, packet-radio communications. *Prerequisite:* EE 8370.

EE 8378 (3). PERFORMANCE MODELING FOR EVALUATION OF COMMUNICATION NETWORKS. This course applies probabilistic modeling and evaluation techniques to understanding the behavior of traffic, switching, and network protocols. Topics include basic queuing theory, traffic models, multiplexing, scheduling, switch models, routing, and traffic control, in the context of protocols such as TCP/I: and ATM. *Prerequisites:* Probability, random processes, and some knowledge of networks. EE 5376/7376 and CSE 6344 recommended.

EE 8382 (3). DIGITAL SIGNAL PROCESSING ARCHITECTURES. Introduction to DSP Systems. Iteration bound. Pipelining and parallel processing; retiming; unfolding and folding. Systolic architecture design. Speed, power, computational, and memory resource design issues. Case studies and design examples for FIR filters, IIR filters, and orthogonal transforms. Archi-

tectural overview of programmable digital signal processors. *Prerequisites:* EE 5372 or equivalent knowledge of digital signal processing concepts, or permission of instructor.

EE 8386 (3). TESTING OF VLSI CIRCUITS. The objective of testing is to verify that the manufactured custom chips function correctly according to their specifications. 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. Cross listed as CSE 8386.

EE 8390 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8391 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8392 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8393 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8394 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8395 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member.

EE 8396 (3). DISSERTATION. This special topics course must have a section number associated with a faculty member.

EE 8490 (4). SPECIAL TOPICS.

EE 8491 (4). SPECIAL TOPICS.

EE 8492 (4). SPECIAL TOPICS.

EE 8493 (4). SPECIAL TOPICS.

EE 8494 (4). SPECIAL TOPICS.

EE 8495 (4). SPECIAL TOPICS.

EE 8496 (4). DISSERTATION.

EE 8596 (5). DISSERTATION.

EE 8690 (6). SPECIAL TOPICS. This special topics course must have a section associated with a faculty member.

EE 8696 (6). DISSERTATION.

EE 8796 (7). DISSERTATION.

EE 8896 (8). DISSERTATION.

EE 8990 (9). DISSERTATION.

EE 8996 (9). DISSERTATION.

Telecommunications Courses (EETS)

EETS courses are designed for the M.S. degree in telecommunications or are taken as a part of the M.S.E.E. with the telecommunications specialization option.

EETS 7090 (0). SPECIAL TOPIC. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in EE 7396 and 7196.

EETS 7301 (3). 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.

EETS 7304 (3). NETWORK PROTOCOLS. This course is an introductory graduate course on the protocol architecture of the Internet, following a bottom-up approach to the protocol layers. The objective of this core course is to provide an understanding of the internetworking concepts in preparation for advanced networking courses. The first part of the course covers networking technologies such as local area networks, packet switching, and ATM. The second part of the course examines the Internet protocol (IP) and TCP/UDP in-depth. The last part of the course is an overview of important application protocols such as HTTP, client/server computing, SMTP, FTP, and SNMP. *Prerequisite:* EETS 7301 or equivalent.

EETS 7305 (3). TELECOMMUNICATIONS REGULATION. This course reviews the evolution of telecommunications in the United States and investigates current regulatory topics, including Internet and international regulation. It relates regulatory decisions to real-world issues such as telecommunications services acquisition and pricing. Also, investigates topics that include both domestic and international components, including regulation of the electromagnetic spectrum and standards organizations.

EETS 7307 (3). TELECOMMUNICATIONS FOR DATA SYSTEMS ENGINEERING. Covers topics related to the technologies and physical management of corporate telecommunications systems, including current voice, data, and wireless telecommunications technologies and hardware. Legal and regulatory topics include a review of regulatory agency responsibilities. Also, intellectual property, net neutrality, privacy and fraud, and facilities planning and management processes, including lease analysis, licensing and permits, bidding contracts, development of specifications, and supplier and vendor management as they pertain to telecommunications systems. Examines engineering topics of fire protection, HVAC, electrical, plumbing, and lighting, and energy management systems for telecommunications. *Prerequisites:* 1 year of physics, including electricity and magnetism, and 1 year of calculus.

EETS 7316 (3). WIRELESS, CELLULAR, AND PERSONAL TELECOMMUNICATIONS. A comprehensive course in the fast-developing field of wireless mobile/cellular and personal telecommunications. Topics include 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. Topics on personal communications include 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 EE 5370 or 7370, or permission of the instructor. This course is primarily for the telecommunications program but can also be very useful for EE students who plan to specialize in this field.

EETS 7341 (3). FIBER OPTIC TELECOMMUNICATIONS. This is an introductory course designed to familiarize students with practical concepts involved in optical fiber communications systems. Basic optical principles are reviewed. Dielectric-slab waveguides, fiber waveguides, and integrated optics devices are discussed. The major components of a fiber communications link, including optical sources, detectors, and fibers, are covered.

EETS 8303 (3). SWITCHING AND ROUTING. Explains switching and routing architectures, protocols, and functions. For switching, covers Spanning Tree Protocol and virtual LANs. Examines dynamic routing protocols, including RIP (versions 1 and 2), OSPF, IS-IS, BGP, and Cisco's EIGRP. Analyzes IP subnetworks with and without classes. Also, uses simulation tools to analyze the operation and performance of different protocols. *Prerequisite:* EETS 7304 or permission of instructor.

EETS 8304 (3). MULTIPROTOCOL LABEL SWITCHING. Three-part course on multiprotocol label switching and its applications in networks: 1) introduction to the basics of MPLS as well as MPLS traffic engineering, DiffServ quality of service, and network survivability; 2) investigation of Layer 2 and Layer 3 MPLS virtual private networks; 3) examination of MPLS management, access networks, MPLS Transport Profile, and GMPLS.

EETS 8305 (3). TELECOMMUNICATIONS SOFTWARE DESIGN. Comprehensive course to familiarize telecommunications professionals with the state-of-the-art software concepts and technology in modern telecommunications applications. Focus on software process modeling, user interface design, CASE tool, reusability, quality assurance, reliability, distributed compu-

ting, real-time operating system and database and understanding of Real-Time Object-Oriented Modeling in analysis and design, high-level programming language design concepts such as C++ as required in telecommunications software development. Heavy emphasis on real-world applications topics 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 instructor, plus knowledge of one high-level programming language, preferably Pascal, C, or C++.

EETS 8311 (3). INTELLIGENT NETWORK. 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. Important IN elements such as the Service Creation Environment, service management systems, service control point, signal transfer point, service switching point, intelligent peripheral will be explained in details. Implementation scenarios for IN elements starting with the ITU-T service independent building blocks to actual service deployment will be described. 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) will be covered. Live demos of IN service creation and execution will be available. *Prerequisite:* EETS 5301 or permission of instructor.

EETS 8313 (3). INTERNET TELEPHONY. Provides 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 the umbrella protocol Session Internet Protocol and its partner, Session Description Protocol. In addition to SIP and SDP, H.323, RSVP, RTP, DNS, TRIP, ISUP, and SS7 are covered. Issues include emergency services, security, mobility, and quality of service. On-campus students – and off-campus students with high-speed Internet access – have access to SIP lab equipment. *Prerequisite:* EETS 7301 or permission of instructor.

EETS 8315 (3). ADVANCED TOPICS IN WIRELESS COMMUNICATION. This course focuses on third generation systems, wireless data, and emerging wireless systems and technologies. It 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. It will also cover second generation wireless data systems such as cellular digital packet data, and short message services. Mobile IP and Wireless Application Protocol are also covered in this class. Some other topics that may be covered include LMDS, WILL, indoor systems, cordless phones, and WLAN.

EETS 8316 (3). WIRELESS NETWORKS. Provides a comprehensive introduction to various transport layer protocols, especially focusing on wireless networks. The course begins with a study of various traffic scenarios in different elements of a wireless network, then looks at various applications using 3G, and finishes with a discussion of methods for performance monitoring and network testing. *Prerequisite:* EETS 7316 (formerly EETS 7306).

EETS 8317 (3). SWITCHING AND QUALITY OF SERVICE MANAGEMENT IN IP NETWORKS. Comprehensive course on Internet protocol switching and QoS management technology, protocols and applications. *Prerequisites:* EETS 7301 or consent of instructor.

EETS 8321 (3). TELECOMMUNICATIONS NETWORK SECURITY. Graduate-level survey of the technologies underlying network security. The first part of the course covers the principles of private and public key cryptography and describes a number of example encryption algorithms, including DES and AES. Next, the use of encryption with hash functions for digital signatures and certificates, followed by perimeter security, including firewalls, intrusion detection systems, viruses, and worms. The last part of the course encompasses a number of secure protocols, including secure email, secure HTTP, IPSec, and virtual private networks. Topics that are part of general security but peripheral to network security are not covered, e.g., physical tamper resistance, security policies, digital rights management, and biometrics.

EETS 8322 (3). DATA COMPRESSION FOR MULTIMEDIA APPLICATIONS. Provides an introduction to techniques for efficient compression and coding of audio and video signals for multimedia applications. Topics covered include 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:* Permission of instructor.

EETS 8331 (3). NETWORK ANALYSIS, ARCHITECTURE, AND DESIGN. A focus on the systematic process of network design. The course explains the process of gathering network requirements and covers data flow analysis and the selection of network architectures. Also, addressing and routing, network management, network performance criteria, and security and privacy architecture selection methods. These techniques are merged to create a complete network design framework. *Prerequisite:* EETS 7304 or permission of instructor.

EETS 8332 (3). ADVANCED NETWORK DESIGN. This capstone course provides a holistic view of network design practices. It begins with a review of network design fundamentals such as conventional and VoIP voice networks, data networks and queuing theory, MPLS, and optical network design methods. These methods are integrated to accomplish and analyze networks from a multilayer network design perspective. A significant portion of the course focuses on completing a complex network design using state-of-the-art software tools. *Prerequisite:* EETS 8331.

EETS 8337 (3). TELECOMMUNICATIONS NETWORK MANAGEMENT. Comprehensive course in the important issues in telecommunications network management. Overview of the underlying principles – operation, administration, maintenance, and provisioning – that 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. Addresses drivers for network management and its traditional practice, as well as future needs, and includes 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++.

EETS 8341 (3). OPTICAL AND DWDM NETWORKS. Discusses the operation of the following network types: Synchronous Optical Network, Synchronous Digital Hierarchy, and Optical Transport Network. Also, optical core and access network configurations. Introduction to WDM network elements, and control and management of optical networks, plus an overview of network survivability using optical technologies. Covers future optical technologies, including photonic packet switching. Students use simulation software in laboratory experiments to analyze the performance and operation of optical networks. *Prerequisite:* EETS 7304 or permission of instructor.

EETS 8390 (3). SPECIAL TOPICS.

EETS 8391 (3). SPECIAL TOPICS.

EETS 8392 (3). SPECIAL TOPIC.

EETS 8393 (3). SPECIAL TOPICS.

ENGINEERING MANAGEMENT, INFORMATION AND SYSTEMS

Associate Professor Richard S. Barr, **Chair**

Professors: Stephen A. Szygenda, Jeff Tian (Computer Science and Engineering). **Associate Professors:** Richard S. Barr, Eli V. Olinick, Jerrell T. Stracener. **Assistant Professor:** Michael Hahsler. **Senior Lecturers:** Leslie-Ann Asmus, Thomas F. Siems. **Lecturers:** Gretchen H. Coleman, Rachel P. Goodman. **Adjunct Faculty:** Karl J. Arunski, Chris L. Askew, John D. Baschab, Charles W. Beall, Robert L. Bell, William D. Bell, Ann E. Broihier, George W. Chollar, Randall J. Clendening, Howard S. Cowin, Christopher M. Davis, Dennis J. Frailey, John R. Graham, III, Michael E. Hopper, John I. Lipp, William H. Muto, William P. Nanry, Robert S. Oshana, David A. Peters, Oscar K. Pickels, Jon C. Piot, James B. Rodenkirch, Christopher A. Rynas, Mark E. Sampson, Nandlal M. Singh, Stephen C. Skinner, Gheorghe M. Spiride, Russell A. Vacante, John W. Via, III, Timothy D. Woods, John R. Yarrow, Hossam A. Zaki. **Emeritus Professor:** Richard V. Helgason.

Graduate Programs

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 Department of Engineering Management, Information and Systems 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 online video, as may most of the coursework for doctoral degrees. More information on distance education delivery systems is in the Off-campus Distance Education section of this catalog.

The Department of Engineering Management, Information and Systems also offers the following, which are described in this section:

- 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.

The most up-to-date information on programs and activities is available on the departmental website at www.smu.edu/Lyle/Departments/EMIS.

Master of Science With a Major in Operations Research

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 an M.S. degree, applicants are required to satisfy the following additional requirements:

1. A B.S. 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 an M.S. 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 With a Major in Systems Engineering

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 an M.S. degree, applicants are required to satisfy the following additional requirements:

1. A B.S. in engineering, mathematics or one of the quantitative sciences. (A B.S. 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 an M.S. 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

The M.S.E.M. 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 M.S.E.M. 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 an M.S. degree, applicants are required to satisfy the following additional requirement: a B.S. in engineering or another technical discipline.

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 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

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 M.S.I.E.M. 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 an M.S. degree, applicants are required to satisfy the following additional requirement: **a 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 an M.S. degree, candidates are required to satisfy the following additional requirements:

1. Satisfactory completion of seven required core courses (21 term credit hours).
2. Satisfactory completion of three electives (nine term credit hours).

Curriculum

The M.S.I.E.M. 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-depth 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

Information Technology Governance and Controls Track

In addition to the seven courses required for the M.S.I.E.M. (EMIS 7351, 7352, 7353, 7357, 7360, 7362 and 8356), the following electives form an IT governance and controls track within the M.S.I.E.M.:

EMIS 7312 Software Systems Engineering
EMIS 7380 Managing Information Technology Controls
EMIS 7382 Information Technology Security and Risk Management

This degree track aligns the M.S.I.E.M. 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 an 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 a Master of Science in Engineering Management; a Master of Science in Information, Engineering and Management; an M.S. with a major in systems engineering; or an M.S. with a major in operations research. Students apply and file degree plans for both degrees, and then complete the coursework. Additional information and examples of programs of study for obtaining two master's degrees from the EMIS department are available at www.smu.edu/Lyle/Departments/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."

Weekend Master's Programs

The Lyle School of Engineering's weekend 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 weekend master's programs, students should see the department website at www.smu.edu/Lyle/Departments/EMIS.

Doctor of Philosophy With a Major in Operations Research

Admission Requirements

1. A 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 3.400 on a 4.000 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 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 Ph.D. 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

In addition to the five steps below, process details and other requirements for the Ph.D. degree may be found elsewhere in the SMU Lyle School of Engineering Graduate Catalog. The steps for completion of the doctoral program are

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 www.smu.edu/Lyle/Departments/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. **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 www.smu.edu/Lyle/Departments/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 With a Major in Systems Engineering

Admission Requirements

Applicants must satisfy these requirements:

1. A 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 3.400 on a 4.000 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 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 Ph.D. 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

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
EMIS 7310 Systems Engineering Design
EMIS 7330 Systems Reliability Engineering
EMIS 7335 Human-Systems Integration
EMIS 7347 Critical Infrastructure Protection/Security Systems Engineering
EMIS 7369 Reliability Engineering
EMIS 8305 Systems Life Cost and Affordability Analysis
EMIS 8307 Systems Test and Evaluation
EMIS 8310 Collective Systems Design
EMIS 8315 Innovation Systems Design
EMIS 8340 Systems Engineering Software Tools
EMIS 8342 Six Sigma Systems Engineering
ME 7350 Design for Manufacturability and Concurrent Engineering

Leadership and Management

CSE 7315 Software Project Planning and Management
EMIS 7318 Systems Engineering Planning and Management
EMIS 7365 Program and Project Management
EMIS 8364 Engineering Management
EMIS 8368 Enterprise Leadership
ME 7303 Organizational Leadership
ME 7368 Project and Risk Management
ME 7369 Innovation Management

Logistics and Supply Systems

CEE 7371 Facility Financial and Asset Management
CEE 8379 Analysis of Transportation Systems
EMIS 7340 Logistics Systems Engineering
EMIS 7362 Production Systems Engineering
EMIS 8348 Supply Chain Systems Engineering
EMIS 8361 Economic Decision Analysis

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

In addition to the five steps below, process details and other requirements for the Ph.D. degree may be found elsewhere in the SMU Lyle School of Engineering Graduate Catalog. The steps for completion of the doctoral program are

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 www.smu.edu/Lyle/Departments/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 With a 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, students should 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 3.400 on a 4.000 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.
   - 59 – Internet-based examination.
   - 213 – computer-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 D.Engr. 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 stu-

dent 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 B.S. in engineering, mathematics or one of the quantitative sciences. A minimum GPA of 3.000 on a scale of 4.000 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 3.000 on a scale of 4.000 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 M.S. 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 (nine term credit hours).
   - **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 (six term credit hours).
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 (six term credit hours) 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

EMIS 7301 Systems Engineering Process
EMIS 7303 Integrated Risk Management
EMIS 7307 Systems Integration and Test

Certificate in Systems Analysis

EMIS 7300 Systems Analysis Methods
EMIS 7305 Systems Reliability, Supportability and Availability Analysis

Certificate in Systems Design and Development

EMIS 7310 Systems Engineering Design
EMIS 7312 Software Systems Engineering

Certificate in Reliability and Logistics Systems Engineering

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 M.S.I.E.M. 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 Strategy** 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 or 7380.
- **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 3.000 or higher on a 4.000 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 (nine term credit hours) with a minimum GPA of 3.000 on a scale of 4.000:

Certificate in Information Engineering Fundamentals

EMIS 7351 Enterprise Fundamentals
EMIS 7352 Information System Architecture
EMIS 7353 Information System Design Strategies

Certificate in Information Engineering Strategy

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

EMIS 7360 Management of Information Technology
EMIS 7380 Managing Information Technology Controls
EMIS 7382 Information Technology Security and Risk Management

Note: EMIS 7351, 7352, 7357, 7360 and 8356 are required for the M.S.I.E.M. degree. Certificates are issued following completion of the certificate requirements and submission of the required administrative forms.

The Courses (EMIS)

EMIS 7049 (0). MASTER'S FULL-TIME STATUS. This course is used to maintain full-time status for master's students in the department of Engineering Management, Information and Systems.

EMIS 7300/EMIS 5300 (3). 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. Specific topics include probabilistic and statistical methods, Monte Carlo simulation, optimization techniques, applications of utility and game theory, and decision analysis.

EMIS 7301 (3). SYSTEMS ENGINEERING PROCESSES. The discipline, theory, economics, and methodology of systems engineering is examined. The historical evolution of the practice of systems engineering is reviewed, as are the principles that underpin modern systems methods. The economic benefits of investment in systems engineering and the risks of failure to adhere to sound principles are emphasized. An overview perspective distinct from the traditional design- and analytical-specific disciplines is developed.

EMIS 7303 (3). INTEGRATED RISK MANAGEMENT. An introduction to risk management based upon integrated trade studies of program performance, cost, and schedule requirements. Topics include risk planning, risk identification and assessment, risk handling and abatement techniques, risk impact analysis, management of risk handling and abatement, and subcontractor risk management. Integrated risk management methods, procedures, and tools will be examined.

EMIS 7305/EMIS 5305 (3). SYSTEMS RELIABILITY, SUPPORTABILITY AND AVAILABILITY ANALYSIS. This course is an introduction to systems reliability, maintainability, supportability and availability modeling and analysis with an application to systems requirements definition and systems design and development. Both deterministic and stochastic models are covered. Emphasis is placed on RMS/A analyses to establish a baseline for systems performance and to provide a quantitative basis for systems trade-offs. *Prerequisite:* EMIS 7300 or equivalent.

EMIS 7307 (3). SYSTEMS INTEGRATION AND TEST. The process of successively synthesizing and validating larger and larger segments of a partitioned system within a controlled and instrumented framework is examined. 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. The significance of structuring and controlling integration and test activities is stressed. Formal methodologies for describing and measuring test coverage, as well as sufficiency and logical closure for test completeness, are presented. Interactions with system modeling techniques and risk management techniques are discussed. 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.

EMIS 7310 (3). 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.

EMIS 7312 (3). SOFTWARE SYSTEMS ENGINEERING. The course 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. The course provides a framework for addressing systems engineering issues by focusing on the Software Engineering Institute's Systems Engineering Capability Maturity Model. Topics include deriving and allocating requirements, system and software architectures, integration, interface management, configuration management, quality, verification and validation, reliability, and risk.

EMIS 7315/EMIS 5315 (3). SYSTEMS ARCHITECTURE DEVELOPMENT. A design-based methodological approach to system architecture development using emerging and current enterprise architecture frameworks. Topics: structured analysis and object-oriented analysis and design approaches are covered; enterprise architecture frameworks, including the Zachman framework, FEAF, DoDAF, and ANSI/IEE-1471; executable architecture model approaches as tools for system-level performance evaluation and trade-off analyses; case studies in enterprise architecture development; and the integration of architecture design processes into the larger engineering-of-systems environment. *Prerequisite:* EMIS 7301.

EMIS 7318 (3). SYSTEMS ENGINEERING PLANNING AND MANAGEMENT. Provides 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 the program manager and systems engineer are unveiled for establishing program operations and communications framework. Techniques are presented 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 providing 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 concluded by planning the transition of systems engineering processes from development to production and field support. *Prerequisite:* EMIS 7301.

EMIS 7320/EMIS 5320 (3). SYSTEMS ENGINEERING LEADERSHIP. This course augments the management principles embedded in the systems engineering process with process design and leadership principles and practices. Emphasis is placed on leadership principles by introducing the underlying behavioral science components, theories and models. The course demonstrates how the elements of systems engineering, project management, process design, and leadership integrate into an effective leadership system. *Prerequisite:* EMIS 7301.

EMIS 7330 (3). SYSTEMS RELIABILITY ENGINEERING.

EMIS 7331 (3). FILE ORGANIZATION AND DATABASE MANAGEMENT. A survey of current database approaches and systems; principles of design and use of these systems. Query language design, implementation constraints. Applications of large databases. Includes a survey of file structures and access techniques. Use of a relational DBMS to implement a database design project. *Prerequisite:* CSE 3358.

EMIS 7332/EMIS 5332 (3). DATA MINING FOR ANALYTICS. Analytics is based on collecting, managing, exploring, and acting on large amounts of data, and it has become a source of competitive advantage for many organizations. This course introduces data-mining techniques (classification, association analysis, and cluster analysis) used in analytics. All material covered is reinforced through hands-on experience using state-of-the art tools to design and execute data-mining processes. *Prerequisite:* Background in descriptive statistics and probability.

EMIS 7335/EMIS 5335 (3). HUMAN-SYSTEMS INTEGRATION. This course advances 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) are presented and discussed. *Prerequisite:* EMIS 7301.

EMIS 7340 (3). LOGISTICS SYSTEMS ENGINEERING.

EMIS 7347/EMIS 5347 (3). CRITICAL INFRASTRUCTURE PROTECTION/SECURITY SYSTEMS ENGINEERING. The purpose of the course is to present 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. Topics include the definition and advantages of SE practices and fundamentals; system objectives that include the viewpoint of the customer, users, and other stakeholders; the elements of the CI and their interdependencies; the impact transportation system disruptions; and system risk analysis. *Prerequisite:* EMIS 7301 and EMIS 7303.

EMIS 7350 (3). 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, arithmetic and matrix computation. Introduction to parallel algorithms. Introduction to computational complexity and a survey of NP-complete problems. *Prerequisite:* CSE 3358 (for non-CSE graduate students: CSE 7311 or 3358).

EMIS 7351/EMIS 3308 (3). ENTERPRISE FUNDAMENTALS. An overview of business fundamentals, spanning the range of all functional areas: management, marketing, operations, accounting, information systems, finance, and legal studies.

EMIS 7352 (3). INFORMATION SYSTEMS ARCHITECTURE. The architecture of an information system (IS) defines that system in terms of components and interactions among those components. This course addresses IS hardware and communications elements for information engineers, including computer networking and distributed computing. It addresses the principles, foundation technologies, standards, trends, and current practices in developing an appropriate architecture for Web-based and non-Internet information systems.

EMIS 7353 (3). INFORMATION SYSTEM DESIGN STRATEGIES. This course surveys the fundamentals of software engineering and database management systems (DBMS) for information engineers. It covers the principles, foundation technologies, standards, trends, and current practices in data-centric software engineering and systems design, including object-oriented approaches and relational DBMS. The focus is on system design, development, and implementation aspects, and not the implementation in code.

EMIS 7355 (3). ENGINEERING OPERATIONS. The management of a technical organization's operations can contribute to the strategic goals and objectives of the enterprise. By analyzing and managing operations such as systems, strategic choices are shown to drive design and operating decisions. The course covers the tools and techniques for solving problems to achieve the overall goals and strategies of manufacturing and services organizations.

EMIS 7357/EMIS 3309 (3). ANALYTICS FOR DECISION SUPPORT. In a rapidly changing, complex environment, successful enterprises make mission-critical choices using decision-support systems, which apply analytical methods to massive organizational data sets to evaluate options, give insight to likely outcomes, and make recommendations of the "best" decisions to pursue. Course topics include 1) framing and understanding decision-making needs and processes to define, evaluate, and identify appropriate strategic, operational, or execution-level decisions; 2) identifying, collecting, and managing large-scale data needed for decision support; and 3) employing decision-support software in areas such as optimization and data mining. Credit not allowed for both EMIS 7357 and EMIS 3309.

EMIS 7359 (3). 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

EMIS 7360/EMIS 5360 (3). 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.

EMIS 7361 (3). 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, introduction to probability or statistics.

EMIS 7362/EMIS 5362 (3). PRODUCTION SYSTEMS ENGINEERING. Applies the principles of engineering, or "design under constraint," to modern production systems. Topics include production systems analysis and design considerations, system design and optimization models and methods, pull- and push-based production systems, quality engineering, and process improvement. Also, techniques for engineering and managing systems with specific architectures: batch-oriented, continuous-flow, projects, and just-in-time. *Prerequisite:* EMIS 8360 recommended.

EMIS 7363 (3). APPLIED PARALLEL PROGRAMMING. Surveys the theory and emphasizes the practice of developing efficient applications software for parallel computers. Topics include 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.

EMIS 7364/STAT 5344/EMIS 5364 (3). 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 are covered. Probabilistic and statistical techniques are applied to modeling and analysis of variability associated with product production and service processes. Topics include analysis of product design tolerances, six-sigma techniques, statistical analysis of process capability, statistical process control using control charts, quality improvement and acceptance sampling. *Prerequisite:* EMIS 4340 or 5370.

EMIS 7365/EMIS 5365 (3). PROGRAM AND PROJECT MANAGEMENT. Development of principles and practical strategies for managing projects and programs of related projects for achieving broad goals. Topics include: planning, organizing, scheduling, resource allocation, strategies, risk management, quality, communications, tools, and leadership for projects and programs.

EMIS 7366/EMIS 5366 (3). 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.

EMIS 7369 (3). RELIABILITY ENGINEERING. Topics include reliability, replacement and maintenance models, failure distributions and reliability functions, process and product control problems. *Prerequisite:* EMIS 4340, 5370, or 7370.

EMIS 7370/STAT 5340 (3). PROBABILITY AND STATISTICS FOR SCIENTISTS AND ENGINEERS. Introduces fundamentals of probability, probability distributions, and statistical techniques used by engineers and physical scientists. Topics include 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:* Knowledge of calculus.

EMIS 7377/STAT 5377/EMIS 5377 (3). STATISTICAL 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. *Prerequisites:* EMIS 4340 and senior standing with a science or engineering major, or permission of the instructor.

EMIS 7380 (3). MANAGING INFORMATION TECHNOLOGY CONTROLS. This course surveys current practices in information technology (IT) governance and controls, with approaches

for balancing business needs with technology controls for high-risk processes. Major topic areas include: 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.

EMIS 7382/EMIS 5382 (3). INFORMATION TECHNOLOGY SECURITY AND RISK MANAGEMENT. This course is for nontechnical managers and executives with decision-making responsibility in information security governance and risk management. Topics include information security organizations and policies, governance, program development and management, information risk management, legal and regulatory compliance, and business continuity planning.

EMIS 7390 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering management, operations research, and/or systems engineering. Topics must be approved by the department chair and the instructor.

EMIS 7396 (3). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in each summer term. Registration in several sections may be needed to obtain the desired number of thesis hours.

EMIS 8049 (0). FULL-TIME STATUS. Graduate full-time status.

EMIS 8096 (0). DISSERTATION. 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.

EMIS 8190 (1). SPECIAL TOPICS. Individual or group study of selected topics in operations research, engineering management, systems engineering or information engineering. *Prerequisite:* Permission of instructor.

EMIS 8196 (1). DISSERTATION. 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.

EMIS 8296 (2). DISSERTATION. 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.

EMIS 8305 (3). SYSTEMS LIFE CYCLE COST AND AFFORDABILITY ANALYSIS. This course will provide an understanding of Systems affordability concepts and the life cycle cost process. The importance of using these concepts in optimizing engineering/business decisions will be examined with emphasis being placed on the evaluation of alternatives weighing costs, risks, reliability, maintainability, supportability, weight, performance, and other benefit/risk parameters. Topics include, 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, 7305.

EMIS 8307 (3). 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. Types of testing will be examined (developments, operations, etc.) as well as the tailoring of testing based on the end user (commercial, military). The T&E process, from requirements analysis through test conduct and reporting, as well as the various types of associated documentation will be covered. Test techniques associated with different disciplines (such as software, reliability, human factors) will be covered. The course concludes with a review of the best practices in systems T&E. *Prerequisites:* EMIS 7301, 7307.

EMIS 8310 (3). COLLECTIVE SYSTEM DESIGN. This course focuses on the design of sustainable and robust systems within organizations. CSD 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 organization processes and systems. The course applies to the design of 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 will enable students' to practice the application of CSD. *Prerequisites:* EMIS 7301, 7310, 8342.

EMIS 8315 (3). INNOVATION IN SYSTEMS DESIGN. This course provides a foundation of modern theory and practice of product innovation in three parts. First, it will review the typical barriers to disruptive innovation: technological, organizational and market-driven. Second,

cases of fast innovation will be reviewed with a focus on systems and technology. Third, the system engineer's role in innovation will be covered 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. *Prerequisite:* EMIS 7301 and 7310.

EMIS 8330 (3). ADVANCED DATABASE MANAGEMENT SYSTEMS. An extensive investigation of distributed databases and implementation issues. Included are design, data replication, concurrency control, and recovery. Implementation project included. *Prerequisite:* EMIS 7330.

EMIS 8331 (3). DATA MINING. This course introduces various data mining concepts and algorithms from a database perspective. A historical background and related topics are first discussed, followed by an overview of data mining core topics (classification, clustering, association rules) and more advanced topics (temporal and spatial data, scalability and parallelization, and outliers). Topics discussed include linear regression, distance measure, decision trees, and neural nets. Case studies and projects are included. *Prerequisite:* EMIS 7330.

EMIS 8337 (3). 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 7330.

EMIS 8340 (3). SYSTEMS ENGINEERING TOOLS. Computerized tools perform the vital function of capturing and delivering Systems Engineering information throughout the product development life cycle. This course surveys 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 through the life cycle of a product they develop. *Prerequisite:* EMIS 7301.

EMIS 8342 (3). 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. Also, developing a quantitative process based on engineering best practices and its application to trade studies, model development, and operations analysis. *Prerequisite:* EMIS 7301.

EMIS 8348 (3). SUPPLY-CHAIN SYSTEMS ENGINEERING. The course introduces supply-chain design, development, and management concepts and principles from a systems perspective. Topics include 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.

EMIS 8350 (3). 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, parallel algorithms. *Prerequisite:* EMIS 7350.

EMIS 8355 (3). GRAPH THEORY. 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 or permission of instructor.

EMIS 8356 (3). INFORMATION ENGINEERING AND GLOBAL PERSPECTIVES. This course examines global and information aspects of technology-based and information-based companies. Topics include modern business processes, the strategic use of information technology, and integration of global information resources for competitive advantage. *Prerequisite:* EMIS 7360.

EMIS 8358/CSE 4360 (3). TECHNICAL ENTREPRENEURSHIP. Development of principles and practical strategies for the management and evolution of rapidly growing technical endeavors. Topics include 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 over an extended period of time. Extensive student presentations and reports are required. Credit will not be given for both CSE 4360 and EMIS 8358. *Prerequisite:* Permission of instructor.

EMIS 8360/EMIS 3360 (3). OPERATIONS RESEARCH MODELS. A survey of models and methods of operations research. Deterministic and stochastic models in a variety of areas will be covered. Credit is not allowed for both EMIS 3360 and EMIS 8360. *Prerequisites:* Knowledge of linear algebra and introductory probability and statistics.

EMIS 8361/EMIS 2360 (3). ENGINEERING ECONOMICS AND DECISION ANALYSIS. Introduction to economic analysis methodology. Topics include 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 not allowed for both EMIS 2360 and EMIS 8361. *Prerequisite:* Knowledge of introductory probability and statistics.

EMIS 8362 (3). ENGINEERING ACCOUNTING. An introduction to and overview of financial and managerial accounting for engineering management. Topics include 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. The focus is on concepts and applications in the industry today.

EMIS 8363 (3). ENGINEERING FINANCE. Develops an understanding of corporate financial decisions for engineers. Topics include cost of capital, capital budgeting, capital structure theory and policy, working capital management, financial analysis and planning, and multinational finance. *Prerequisite:* EMIS 8361 or knowledge of time value of money.

EMIS 8364 (3). 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. This course will 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. Pre-requisite: Graduate standing in engineering.

EMIS 8368 (3). ENTERPRISE LEADERSHIP. The study of how companies link strategy and action at the enterprise level: shaping, and leveraging the work performed by the multi-firm enterprises that jointly produce added value for customers, while building and retaining competencies critical for competitive advantage.

EMIS 8370 (3). STOCHASTIC MODELS. Model building with stochastic processes in applied sciences. Phenomena with uncertain outcomes are formulated as stochastic models and their properties are analyzed. Specific problems come from areas such as population growth, queueing, reliability, time series, and social and behavioral processes. Statistical properties of the models are emphasized. *Prerequisites:* STAT 5373 and graduate standing.

EMIS 8371 (3). LINEAR PROGRAMMING. A complete development of theoretical and computational aspects of linear programming. *Prerequisite:* Knowledge of linear algebra.

EMIS 8372 (3). QUEUEING THEORY. Queueing 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 queueing models with emphasis on their performance characteristics. *Prerequisite:* EMIS 7370 or permission of instructor.

EMIS 8373 (3). INTEGER PROGRAMMING. A presentation of algorithms for linear integer programming problems. Topics include complexity analysis, cutting plane techniques, and branch-and-bound. *Prerequisite:* EMIS 8360 or 8371.

EMIS 8374 (3). NETWORK FLOWS. A presentation of optimization algorithms and applications modeling techniques for network flow problems. Topics include pure, generalized, integer, and constrained network problems, plus special cases of each, including transportation, assignment, shortest-path, transshipment, multicommodity, and nonlinear networks. Case studies illustrate the uses of network models in industry and government settings.

EMIS 8378 (3). 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. Topics include linear, integer, network, nonlinear, multi-objective,

and stochastic optimization models for manufacturing, logistics, telecommunications, service operation, and public sector applications.

EMIS 8380 (3). MATHEMATICS FOR OPTIMIZATION. The purpose of this course is to present 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. Traditional supporting material covering real-valued functions in multidimensional space receive a thorough review. Theoretical material supporting linear programming and nonlinear programming will be presented. MATLAB will be used for examples and projects. Homework will consist primarily of the construction of proofs.

EMIS 8381 (3). NONLINEAR PROGRAMMING. Topics include convexity analysis, nonlinear duality theory, Kuhn-Tucker conditions, algorithms for quadratic programming, separable programming: gradient and penalty methods. *Prerequisite:* EMIS 8371.

EMIS 8382 (3). THEORY OF OPTIMIZATION. Lagrange multiplier theory, fixed-point representations. Duality and convex analysis and subgradient relationship. *Prerequisite:* EMIS 8371.

EMIS 8390 (3). GRADUATE SEMINAR. Special and intensive study of selected topics in operations research, engineering management, systems engineering, and information engineering. Varies by topic and instructor.

EMIS 8393 (3). GRADUATE SEMINAR. Special and intensive study of selected 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.

EMIS 8394 (3). SELECTED PROBLEMS. Independent investigation of topics in operations research, engineering management, systems engineering, and information engineering approved by the department chair and by the major professor. *Prerequisite:* 12 term hours of graduate credit.

EMIS 8395 (3). SELECTED PROBLEMS. Independent investigation of topics in operations research, engineering management, systems engineering, and information engineering approved by the department chair and by the major professor. *Prerequisite:* 12 term hours of graduate credit.

EMIS 8396 (3). DISSERTATION. 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.

EMIS 8696 (6). DISSERTATION. 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.

EMIS 8996 (9). DISSERTATION. 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.

MECHANICAL ENGINEERING

Professor Ali Beskok, **Chair**

Professors: Ali Beskok, Yildirim Hürmüzlü, Radovan B. Kovacevic, Paul S. Krueger, José L. Lage, M. Volkan Otugen, Peter E. Raad, Wei Tong. **Associate Professors:** Charles M. Lovas, Edmond Richer, David A. Willis. **Assistant Professors:** Tindaro Ioppolo, Jeong Ho You. **Senior Lecturers:** Elena V. Borzova, Dona T. Mularkey. **Clinical Associate Professor:** Adam L. Cohen. **Adjunct Faculty:** Bogdan V. Antohe, Eric B. Cluff, Matthew L. Durchholz, Fawzi Elghadamsi, Santos Garza, M. Wade Meaders, David J. Nowacki, Allen D. Tilley, Andrew K. Weaver, James R. Webb. **Emeritus Professors:** David B. Johnson, Bijan Mohraz, Paul F. Packman, Cecil H. Smith, Hal Watson, Jr.

Graduate Programs

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. The department's 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. The Mechanical Engineering Department offers the following graduate degrees:

Master of Science in Mechanical Engineering
Master of Science (Major in Manufacturing Systems Management)
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 bioengineering (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 an M.S. degree, applicants are required to satisfy the following additional requirement: a B.S. in mechanical engineering or a closely related discipline.

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 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 with at least three members and 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 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 8386 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 With a 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 manufacturing systems management 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 an M.S. degree, applicants are required to have a B.S. in one of the engineering disciplines or a closely related scientific field, or five years of directly relevant professional experience.

Degree Requirements

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

In addition to meeting the Lyle School of Engineering admission requirements for an M.S. degree, applicants are required to have a B.S. in one of the engineering disciplines or a closely related scientific field, 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.

Doctor of Philosophy With a Major in Mechanical Engineering

The Ph.D. program is one of the most successful programs in the nation. The majority of 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. An M.S. 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 3.000 on a 4.000 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 Ph.D. degree, candidates are required to satisfy the following:

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.
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 the Lyle School of Engineering laboratories is to support high-quality practical research and technological innovations.

The **Laboratory for Porous Materials Applications** is concerned with modeling; numerical simulation; and experimental testing of mass, energy and momentum transport in heterogeneous and porous media.

The **Nanoscale Electrothermal Sciences Laboratory** focuses on noninvasive characterization of the thermal properties of thin-film materials.

The **Laser Micromachining Laboratory** conducts studies of laser-assisted microfabrication, including high-power laser ablation and laser micro-machining.

The **Experimental Fluid Mechanics Laboratory** focuses on pulsed jet micropropulsion and flow-through porous media.

The **Micro, Nano and Biomechanics of Materials Laboratory** supports research primarily in the area of solid mechanics and materials engineering, with a focus on the combined experimental characterization as well as the computational analysis of mechanical properties, stress/strain, and microstructure of engineering and biological materials. Applications in advancing manufacturing and materials processing technologies, engineering design analyses, and biomedical sciences and engineering are also studied in this facility.

The **Systems, Measurement and Control Laboratory** is 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.

The **Micro-Sensor Laboratory** focuses on research in the development of micro-optical sensors for a wide range of aerospace and mechanical engineering applications, including temperature, pressure, force, acceleration and concentration. A major research component in this lab is concentrated on the study of the optical phenomenon called the "whispering gallery modes" and its exploitation for sensor development in the micro-size level with a nano-level measurement sensitivity.

The **Systems Laboratory** is dedicated to analysis and modeling of bipedal gait dynamics, rigid body impact mechanics and the pneumatically operated haptic interface system.

The **Research Center for Advanced Manufacturing** supports research and development activities in areas of rapid prototyping and manufacturing (laser-based and welding-based deposition), laser materials processing (welding, forming, surface modification), welding (including electrical arc welding, variable polarity plasma arc welding, friction stir welding and micro plasma arc welding), waterjet/abrasive waterjet materials processing, sensing and control of manufacturing processes, and numerical modeling of manufacturing processes. The **Center for Laser-Aided Manufacturing** is housed in the RCAM facility, and it collaborates with RCAM.

The **Energy Harvesting Materials Laboratory** focuses on the investigation and design of materials to generate electricity from solar light (solar cells), from mechanical vibration (piezoelectric power generators) and from temperature difference (thermoelectric systems). Due to the limited reserves of fossil fuels like coals, oil and natural gas, finding an efficient way to produce renewable energy from natural resources is in great demand. Research focuses on small-scale materials (nanomaterials) to improve energy conversion efficiency in those systems based on atomic-scale and continuum approaches.

The **Biomedical Instrumentation and Robotics Laboratory** supports research activities that promote strong interdisciplinary collaboration between several branches of engineering and biomedical sciences. The research interests are centered on two areas:

- Medical robotics, especially novel robotic applications in minimally invasive, natural orifice, and image-guided and haptic-assisted surgery.
- In vivo measurement of mechanical properties of biological tissue.

These areas of concentration touch upon fundamentals in analytical dynamics, nonlinear control of mechanical systems, computer-aided design and virtual prototyping, applied mathematics, data acquisition, signal processing, and high-performance actuators.

The **Microsystems Research Laboratory** focuses on research in the area of optical actuators and sensors, micro-optofluidics, energy conversion and smart materials.

The **BioMicrofluidics Laboratory** supports designing, building and testing lab-on-a-chip devices for biomedical, environmental monitoring, and food and water safety applications. Students perform numerical simulations of mass momentum and energy transport in micro- and nano-scales using continuum-based and atomistic methods.

The **Additive Manufacturing, Robotics and Automation Laboratory** is engaged in research sponsored by the National Science Foundation's National Robotics Initiative. It is dedicated to the development of advanced, multimaterial 3-D printing technology as applied to the manufacturing of soft robotic components. Other contemplated research areas include robotic technologies for minimally invasive medical procedures and automated construction systems.

The Courses (ME)

All on-campus mechanical engineering graduate students are expected to enroll and participate each term in the graduate seminar course ME 7090. Special courses are courses reflecting specific areas of interest that have not been taught on a regular basis and may be offered if sufficient interest is shown.

Advanced Special Topics	
Graduate Seminar	ME 7090
Master's Thesis	ME 7(0,1,2,3,6)96
Seminar Series on Ethics in Engineering and Technology	ME 7190
Selected Problems	ME 7(1–4)9(4–5)
Advanced Topics II	ME 7384
Selected Topics	ME 7(1–9)9(0–3); 8(1–9)9(0–4)
Dissertation	ME 8(0,1,6,9)96
Special Courses	ME 8325, 8326, 8327

ME 7049 (0). MASTER'S FULL-TIME STATUS.

ME 7090 (0). GRADUATE SEMINAR.

ME 7096 (0). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in ME 7396 and 7196.

ME 7190 (1). GRADUATE SEMINAR: ETHICS IN ENGINEERING AND TECHNOLOGY. Covers ethical issues, hard choices, and human failures in life. Practical, ethical issues will be discussed with examples from everyday life. Ethical issues encountered in copyright law and intellectual property, along with issues involved in telephone communications and email will be presented. Principles, methods, and bases for ethical decision-making and action will be discussed.

ME 7194 (1). SELECTED PROBLEMS. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

ME 7196 (1). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Students may enroll in several sections to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in ME 7396 and 7196.

ME 7294 (2). SELECTED PROBLEMS. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

ME 7296 (2). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in ME 7396 and 7196.

ME 7301 (3). ENTREPRENEURSHIP AND BUSINESS DEVELOPMENT IN MANUFACTURING. A perspective of entrepreneurial thought that provides the necessary tools for starting a manufacturing venture. Management is the process of creating value from existing resources; in contrast, entrepreneurship is the area of creating the ideas and identifying and assembling the resources to create value. Students address this art for new ventures inside existing corporations and de novo startups in the manufacturing realm, learn what personality characteristics are important and effective in each of these settings and where they fit, learn the risks and rewards of each approach, and acquire the tools required to develop a business plan. Course content enables students to answer the most frequently asked questions about entrepreneurship. Examples, exercises, and cases will be drawn from a manufacturing environment.

ME 7302 (3). LINEAR SYSTEM ANALYSIS. The course will introduce students to the topics within the domain of modern control theory. Special emphasis will be placed on the application of the developed concepts in designing linear systems and casting their responses in prescribed forms. Topics covered are state representation of linear systems, controllability, observability, and minimal representation, linear state variable feedback, observers and quadratic regulator theory. *Prerequisite:* ME 4360/EE 3370 or permission of instructor.

ME 7303 (3). ORGANIZATIONAL LEADERSHIP. This is a course in personnel and organizational leadership. Students learn the scientific structure of organizations and methods used to improve the productivity and quality of life of people working in the organization. Also, introduces industrial-organizational (I/O) psychology as applied to the manufacturing organization. This course will focus on understanding individual behavior and experiences in industrial and organizational settings. Students are 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.

ME 7314 (3). INTRODUCTION TO MICROELECTROMECHANICAL SYSTEMS AND DEVICES. This course develops the basics for 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.

ME 7319 (3). 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, temperature-dependent and environment-dependent mechanical properties. *Prerequisite:* ME 2340, ME 3340, or permission of the instructor.

ME 7320/ME 5320 (3). INTERMEDIATE DYNAMICS. Kinematics and dynamics of particles and rigid bodies: kinematics, inertia properties, Kane's dynamical equations. Euler's equations of motion, D'Alembert's principle, Lagrange's equations of motion. *Prerequisite:* ME 2320, MATH 2339, MATH 2343 or permission of instructor.

ME 7321 (3). FAILURE ANALYSIS AND PREVENTION. A senior-graduate course in the evaluation of the failure of structural materials and components. Topics include site examination, macroscopic examination, optical microscopy, transmission electron and SEM interpretation, examination and interpretation of failure surfaces, failure modes, causes of failure. *Prerequisite:* ME 3340 or permission of instructor.

ME 7322/ME 5322 (3). 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. *Prerequisite:* ME 2320, MATH 2343, or permission of instructor.

ME 7323 (3). 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.

ME 7324 (3). 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 versus safe life design, crack propagation. Emphasizes engineering design aspects of fatigue rather than theoretical mechanisms. *Prerequisite:* ME 3340 or permission of instructor.

ME 7326 (3). 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 oversteer 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.

ME 7330 (3). HEAT TRANSFER. Application of the principles of conduction, convection, and radiation heat transfer. Steady and unsteady state, special configurations, numerical and analytical solutions, and design are topics included. *Prerequisite:* ME 3332 or permission of the instructor.

ME 7331 (3). 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, 3341 or permission of instructor.

ME 7332 (3). HEAT TRANSFER IN THE 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.

ME 7333 (3). 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 is placed 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, 3332 or permission of instructor.

ME 7334 (3). FUNDAMENTALS OF ELECTRONIC PACKAGING. This course covers the introduction to microsystems packaging, role of packaging in microelectronics, role of packaging in microsystems, electrical package design, design for reliability, thermal management, single-chip and multichip packaging, IC assembly, passive devices, optoelectronics, RF packaging, MEMS, sealing and encapsulation, system-level PWBs, PWB assembly, packaging materials and processes, and microsystem design for reliability.

ME 7335/ME 5335 (3). CONVECTIVE COOLING OF ELECTRONICS. This course will begin with a review of the fundamental concepts of convection heat transfer, followed by applications of these principals to the convective cooling of electronic components and systems. The following special topics will be emphasized: design of natural- and forced- convection heat sinks with both air- and liquid-cooling, fan and pump selection procedures, including piezoelectric fans and micropumps, acoustic fan noise and noise measurement techniques, augmentation of convection heat transfer in the form of plate-fin and pin-fin extended surfaces, spray cooling, jet-impingement cooling, microchannel cooling, heat pipes, and capillary pumped loops. In addition, the course will cover pool boiling and flow boiling as applied to the thermal management of electronics. The design of electronic chassis with flow through coldwalls and edge-cooled PWBs will be examined. Several industry-related applications will be used as examples. *Prerequisite:* Senior undergraduate or graduate student standing.

ME 7336 (3). INTERMEDIATE FLUID DYNAMICS. Review of fundamental concepts of undergraduate fluid mechanics and introduction to advanced fluid dynamics, industrial irrotational flow, tensor notation, and the Navier-Stokes equations. *Prerequisite:* ME 2342 or permission of instructor.

ME 7337/ME 5337 (3). INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS: FUNDAMENTALS OF FINITE DIFFERENCE METHODS. Concepts of stability, convergence, accuracy, and consistency. Applications to linear and non-linear 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 instructor.

ME 7340/CEE 5340/ME 5340/CEE 7340 (3). INTRODUCTION TO SOLID MECHANICS. Three dimensional stress and strain, failure theories, introduction to two-dimensional elasticity, torsion of prismatic members, beams on elastic foundation, introduction to plates and shells, and energy methods. *Prerequisites:* ME 2340 and MATH 2343.

ME 7341 (3). 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.

ME 7342/ME 5342 (3). INTRODUCTION TO THERMAL MANAGEMENT OF ELECTRONICS. The 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.

ME 7343/ME 5343 (3). ELECTRONIC PACKAGING MATERIALS: PROCESSES, PROPERTIES, AND TESTING. This course will focus on an overview of materials used in electronic packaging. It will examine solderability, microscopic processes and alloy selection. It will look at composites and applying conducting polymer-matrix composites, metal films, and vacuum processes. The importance of encapsulation, temperature humidity bias testing, and temperature cycle testing will be covered. Measurement of properties of material in electronic packaging, thermal properties, physical properties and manufacturing properties, and materials selection will also be covered. *Prerequisite:* Senior undergraduate or graduate student standing.

ME 7344/ME 5344 (3). CONDUCTIVE COOLING OF ELECTRONICS. This course will begin with a review of the fundamental concepts of conduction heat transfer, followed by applications of these principals to the conductive cooling of electronic components and systems. The following special topics will be emphasized: contact conductance, interface thermal resistance, heat spreaders, thermal interface materials, phase change materials, thermoelectric devices, Stirling cycle refrigerators, and the cooling of special electronic components, such as multi-chip modules, power modules, high density power supplies, and printed wiring boards. The thermal management by conduction of GaAs and GaN monolithic microwave integrated circuits will be featured. Both steady state and transient analyses will be employed, including a discussion of transient junction-to-case thermal resistance measurements. *Prerequisite:* Senior undergraduate or graduate student standing.

ME 7348/ME 5348 (3). THERMAL, FLUID, AND MECHANICAL MEASUREMENTS IN ELECTRONICS. The following thermal and fluid measurement topics will be covered: the 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, design of wind tunnels, flow visualization techniques, and characterization of electronic components. Experimental procedures used for vibration and shock testing of electronic equipment will be covered. The instrumentation and test procedures used for complex environmental testing to commercial and military specifications will be described. In addition, the basic principles of acoustics and the measurement techniques used to evaluate noise levels generated by electronic systems will be covered. *Prerequisite:* Senior undergraduate or graduate student standing.

ME 7351 (3). COMPUTER INTEGRATED MANUFACTURING SYSTEMS. This course covers the basic concepts and use of computer integrated manufacturing. Topics include integration approaches for manufacturing, process planning and simulation, the production process in relation to automated control systems, process design for shop for 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. Economic justification and the use of artificial intelligence for planning and process control will be examined.

ME 7352 (3). MANUFACTURING METHODS AND SYSTEMS. This course is intended as an overview 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, pokayoke 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 operation will be covered. The course will be presented from the perspective of the manufacturing manager.

ME 7353 (3). 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.

ME 7354 (3). 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, reliability are covered in detail. Taguchi and poka-yoke and other practices are examined as tools for implementing TQM.

ME 7358 (3). 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 failure, designing electronics for random vibration, acoustic noise effects on electronics, shock environments, design of electronic boxes, effects of manufacturing methods on reliability of electronics, and vibration testing. *Prerequisites:* ME 2320, MATH 2343.

ME 7361/CEE 7361/CEE 5361/ME 5361 (3). MATRIX STRUCTURE ANALYSIS. A systematic approach to formulation of force and displacement method of analysis; representation of structures as assemblages of elements; computer solution of structural systems. *Prerequisite:* ME 3350 or permission of instructor.

ME 7362 (3). 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.

ME 7363/ME 5363 (3). ELECTRONIC MANUFACTURING TECHNOLOGY. This course covers the complete field of electronics manufacturing. Topics include an introduction to the electronics industry, electronic components, interconnections, printed wiring boards, and soldering and solderability. Automated assembly, including leaded component insertion and surface mount device placement, will be covered. Packaging techniques such as wire bonding, flip chip, and TAB, electro-magnetic interference, electrostatic discharge prevention, testability and electronic stress screening will be covered. A variety of manufacturing systems will be covered. *Prerequisite:* Senior undergraduate or graduate student standing.

ME 7364/CEE 7364/ME 5364/CEE 5364 (3). 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 its applications to analysis of framed structures; introduction to systems with distributed mass and flexibility. *Prerequisite:* MATH 2343 or permission of instructor.

ME 7365 (3). STRATEGIES FOR MANUFACTURING. This course examines the development and implementation of strategies for product design and manufacturing that best supports the overall strategy of the firm. Topics include 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. Case studies of manufacturing firms are used extensively. *Prerequisite:* Graduate student standing.

ME 7366 (3). GLOBAL MANUFACTURING. This course examines goals and strategies for manufacturing operations in the multinational environment. Topics include 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. Case studies of manufacturing firms are used. *Prerequisite:* Graduate student standing.

ME 7368/ME 5368 (3). PROJECT AND RISK MANAGEMENT. Focuses on specific concepts, techniques and tools for managing projects successfully. Network planning techniques, resource

allocation, models for multiproject scheduling, methods of controlling costs, determining schedules and performance parameters. The basics of risk management including hard analysis, risk analysis, risk control, and risk financing are covered. The focus of the course is to integrate risk assessment with managerial decision making. Examples and case studies are emphasized.

ME 7369 (3). 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, 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 theory of inventive problem-solving. Students will practice methods through the case study method and explore and develop disruptive innovation in a class project.

ME 7371/ME 5371 (3). INTRODUCTION TO GAS DYNAMICS AND ANALYSIS 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, 2331 or permission of instructor.

ME 7372/ME 5372/ME 2372 (3). INTRODUCTION TO CAD. Introduction to CAD. Introduction to mechanical computer aided design. Survey of technical topics related to computer-aided design and computer-sided manufacturing. 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 computer-aided design system. *Prerequisite:* Graduate standing.

ME 7376 (3). ROBOTICS: INTRODUCTION TO 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:* College physics, differential equations, computer programming.

ME 7377/CEE 7377/CEE 5377/ME 5377 (3). 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:* ME 4350.

ME 7380/CEE 5380/CEE 7380 (3). MANAGEMENT OF INDUSTRIAL AND MISSION-CRITICAL FACILITIES. Efficient industrial centers require balanced consideration with respect to facility design and function. Mission-critical component management and information technology systems are designed for exceptionally reliable performance and efficient operation. This course emphasizes the component systems that are designed to maintain a high level of function. Covers electrical and mechanical reliability, efficiency, readiness, robustness, and flexibility, and the management of the information technology systems. Explores strategies designed to eliminate costly downtimes, with emphasis on standby generators; automatic transfer switches; uninterruptable power supplies; fuel, fire, and battery systems; energy security; and environmental and cooling technologies. Presents the implementation of sustainable technology, green certifications, and alternative energy strategies that are compatible with the mission-critical requirements of the facility. Includes operational approaches to reduce energy requirements for power and cooling, mandated safety standards, and environmental codes. *Prerequisite:* Graduate standing or permission of instructor.

ME 7381/CEE 5381/CEE 7381 (3). SITE SELECTION FOR INDUSTRIAL AND MISSION-CRITICAL FACILITIES. Efficient industrial centers and facilities with mission-critical subsystems such as datacenters require balanced considerations with respect to facility design and site location. Site location plays an integral role in creating successful projects that especially support high reliability and promote sustainable design. While the important factors may vary from site to site, in any given instance a single factor can undermine the success of an otherwise excellent project. Ready availability and proper site selection that minimizes risk of disruption are particularly important factors for successful operation. Covers siting considerations, including power needs, electrical mix, weather patterns, building codes, proximity to the workforce and transportation, and other topics that bear on reliable operation. Emphasizes strategies of site selection to adequately safeguard hardware and mission-critical data. *Prerequisite:* Graduate standing or permission of instructor.

ME 7382 (3). FINANCE AND THE MANUFACTURING ENTERPRISE. This course contains 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 will be placed on how engineering and manufacturing managerial functions interact with the finance industry, markets and institutions. *Prerequisite:* Graduate student standing.

ME 7383/CEE 7383/ME 5383/CEE 5383 (3). HEATING, VENTILATING, AND AIR CONDITIONING. Selection and design of basic refrigeration, air conditioning, and heating systems are treated. Load calculations, psychometrics, cooling coils, cooling towers, cryogenics, solar energy applications, and special topics are included. *Prerequisites:* ME 2331, 3332 or permission of instructor.

ME 7384 (3). ADVANCED TOPICS II. Advanced selected topics in mechanical engineering and its application (on request).

ME 7391 (3). SELECTED TOPICS. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

ME 7392 (3). SELECTED TOPICS. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

ME 7393 (3). SELECTED TOPICS. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

ME 7394 (3). SELECTED PROBLEMS. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

ME 7395 (3). SELECTED PROBLEMS. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

ME 7396 (3). MASTER'S THESIS. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in ME 7396 and 7196.

ME 7494 (4). SELECTED PROBLEMS. Independent investigation of problems and projects in mechanical engineering approved by the department chair and the major professor (on request).

ME 7696 (6). MASTER'S THESIS. No more than 6 term hours in a single term, and no more than 4 term hours in a summer term. Enrollment in several sections may be needed to obtain the desired number of thesis hours. For example, 4 term hours of thesis would require enrollment in ME 7396 and 7196.

ME 8049 (0). PH.D. FULL-TIME STATUS. Full-Time status for students in the Ph.D. program.

ME 8096 (0). DISSERTATION. No more than 15 term hours in a single term, and no more than 10 term hours in a summer term. 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 8990.

ME 8196 (1). DISSERTATION. No more than 15 term hours in a single term, and no more than 10 term hours in a summer term. 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 8990.

ME 8296 (2). DISSERTATION. No more than 15 term hours in a single term, and no more than 10 term hours in a summer term. 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 8990.

ME 8338 (3). VISCOUS FLOW THEORY. A study of the motion of viscous fluids; low Reynolds number and laminar boundary-layer theory for a Newtonian fluid; exact and approximate methods for solution of problems. *Prerequisite:* ME 2342 or permission of instructor. *Corequisite:* MATH 6333 or permission of instructor.

ME 8339 (3). 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; atmosphere shear flows. *Prerequisite:* ME 8338 or permission of instructor.

ME 8340/CEE 8340 (3). 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 is covered. *Prerequisite:* ME 7340 or permission of instructor.

ME 8342 (3). THEORY OF PLASTICITY. Physical basis of plastic deformation, mathematical theory of yield and plastic flow with applications to various engineering problems. *Prerequisite:* Permission of instructor.

ME 8344 (3). ENERGY METHODS IN APPLIED MECHANICS. The variational energy principles of mechanics are discussed and applied to analysis of beams and trusses; general elasticity problems; plates and shells; buckling; and dynamics. *Prerequisite:* ME 7340 or permission of instructor.

ME 8346 (3). 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 instructor.

ME 8361 (3). 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. Interaction indices and H-matrices. Design examples. *Prerequisite:* ME 4360 or permission of instructor.

ME 8364/CEE 8364 (3). 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 instructor.

ME 8366/CEE 8366 (3). 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.

ME 8367 (3). NONLINEAR CONTROL. This course introduces the student to methods of the control of nonlinear systems. The course reviews phase plane analysis of nonlinear systems, Lyapunov theory, nonlinear stability and describing function analysis. Advance control techniques include feedback linearization, sliding control, and adaptive control. Special emphasis will be placed 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 instructor.

ME 8368/CEE 8368 (3). THEORY OF PLATE BEHAVIOR. Analysis of flat plates subjected to normal loading, inplane loading, and thermal stresses. Plates of various shapes, thick plates, and anisotropic plates are analyzed for both small and large deflections. *Prerequisite:* ME 7340 or permission of instructor.

ME 8369 (3). 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.

ME 8385 (3). CONDUCTION HEAT TRANSFER. Analytical and numerical methods are applied to several cases of steady and unsteady state conduction. Temperature dependent properties, multi-dimensional system, and heat sources are included.

ME 8386 (3). 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 7330 or equivalent.

ME 8387 (3). 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 convention-radiation problems. *Prerequisite:* ME 3332 or permission of instructor.

ME 8390 (3). SELECTED TOPICS. Individual or group study of selected topics in mechanical engineering approved by the department chair and the instructor (on request).

ME 8391 (3). SELECTED TOPICS. Individual or group study of selected topics in mechanical engineering approved by the department chair and the instructor (on request).

ME 8393 (3). SELECTED TOPICS. Individual or group study of selected topics in mechanical engineering approved by the department chair and the instructor (on request).

ME 8394 (3). SELECTED TOPICS. Individual or group study of selected topics in mechanical engineering approved by the department chair and the instructor (on request).

ME 8396 (3). DISSERTATION. No more than 15 term hours in a single term, and no more than 10 term hours in a summer term. 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 8990.

ME 8690 (6). SELECTED TOPICS. Individual or group study of selected topics in mechanical engineering approved by the department chair and the instructor (on request).

ME 8696 (6). DISSERTATION. No more than 15 term hours in a single term, and no more than 10 term hours in a summer term. 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 8990.

ME 8990 (9). SELECTED TOPICS. Individual or group study of selected topics in mechanical engineering approved by the department chair and the instructor (on request).

ME 8996 (9). DISSERTATION. 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 enrollment in ME 8390 and 8990.

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Ali Beskok, *Professor of Mechanical Engineering,* Ph.D., Princeton

Elena V. Borzova, *Senior Lecturer of Mechanical Engineering,* Ph.D., SMU

Jerome K. Butler, P.E., *University Distinguished Professor of Electrical Engineering,* Ph.D., Kansas

Joseph D. Camp, *Assistant Professor of Electrical Engineering and J. Lindsay Embrey Trustee Professor,* Ph.D., Rice

Frederick R. Chang, *Bobby B. Lyle Endowed Centennial Distinguished Chair in Cyber Security and Professor of Computer Science and Engineering,* Ph.D., Oregon

Marc P. Christensen, *Professor of Electrical Engineering and Bobby B. Lyle Endowed Professor of Engineering Innovation,* Ph.D., George Mason

Adam L. Cohen, *Clinical Associate Professor of Mechanical Engineering,* B.S., Massachusetts Institute of Technology

Gretchen H. Coleman, *Lecturer of Engineering Management, Information and Systems,* M.B.A., Texas (Arlington)

Frank P. Coyle, *Senior Lecturer of Computer Science and Engineering,* Ph.D., SMU

Carlos E. Davila, *Associate Professor of Electrical Engineering,* Ph.D., Texas

Scott C. Douglas, *Professor of Electrical Engineering,* Ph.D., Stanford

James G. Dunham, P.E., *Associate Professor of Computer Science and Engineering and Associate Professor of Electrical Engineering,* Ph.D., Stanford

Jennifer A. Dworak, *Assistant Professor of Computer Science and Engineering,* Ph.D., Texas A&M

John H. Easton, *Visiting Lecturer of Civil and Environmental Engineering,* Ph.D., Alabama (Birmingham)

Usama S. El Shamy, P.E., *Associate Professor of Civil and Environmental Engineering,* Ph.D., Rensselaer Polytechnic Institute

Daniel W. Engels, *Associate Professor of Computer Science and Engineering,* Ph.D., Massachusetts Institute of Technology

Delores M. Etter, *Professor of Computer Science and Engineering, Professor of Electrical Engineering and Texas Instruments Distinguished Chair in Engineering Education,* Ph.D., New Mexico

Donald E. Evans, *Lecturer of Computer Science and Engineering,* D.M.A., North Texas

Gary A. Evans, P.E., *Professor of Electrical Engineering,* Ph.D., California Institute of Technology

Mark E. Fontenot, *Lecturer of Computer Science and Engineering,* M.S., SMU

Rachel P. Goodman, *Lecturer of Engineering Management, Information and Systems,* M.S., SMU

W. Milton Gosney, P.E., *Professor of Electrical Engineering and Cecil and Ida Green Chair of Engineering,* Ph.D., California (Berkeley)

Ira Greenberg, *Professor of Creative Computation,* M.F.A., Pennsylvania

Ping Gui, *Associate Professor of Computer Science and Engineering and Associate Professor of Electrical Engineering,* Ph.D., Delaware

Michael Hahsler, *Assistant Professor of Engineering Management, Information and Systems,* Ph.D., Wirtschaftsuniversität Wien

LiGuo Huang, *Associate Professor of Computer Science and Engineering,* Ph.D., Southern California

Yildirim Hürmüzlü, *Professor of Mechanical Engineering,* Ph.D., Drexel

Tindaro Ioppolo, *Assistant Professor of Mechanical Engineering and Brown Foundation, Inc. Professor of Engineering,* Ph.D., New York: Polytechnic Institute

Mohammad Khodayar, *Assistant Professor of Electrical Engineering,* Ph.D., Illinois Institute of Technology

Alireza Khotanzad, P.E., *Professor of Electrical Engineering,* Ph.D., Purdue

M. Scott Kingsley, *Lecturer of Electrical Engineering,* D.E., SMU

Radovan B. Kovacevic, *Professor of Mechanical Engineering and Herman Brown Chair in Engineering,* Ph.D., Montenegro (Yugoslavia)

Paul S. Krueger, *Professor of Civil and Environmental Engineering and Professor of Mechanical Engineering,* Ph.D., California Institute of Technology

José L. Lage, P.E., *Professor of Mechanical Engineering,* Ph.D., Duke

Eric C. Larson, *Assistant Professor of Computer Science and Engineering,* Ph.D., Washington

Choon S. Lee, *Associate Professor of Electrical Engineering,* Ph.D., Illinois (Urbana-Champaign)

Charles M. Lovas, P.E., *Associate Professor of Mechanical Engineering,* Ph.D., Notre Dame

Theodore W. Manikas, *Lecturer of Computer Science and Engineering,* Ph.D., Pittsburgh

David W. Matula, *Professor of Computer Science and Engineering,* Ph.D., California (Berkeley)

Tyler W. Moore, *Assistant Professor of Computer Science and Engineering,* Ph.D., Cambridge

Dona T. Mularkey, *Senior Lecturer of Mechanical Engineering,* Ph.D., Vanderbilt

Sukumaran V.S. Nair, P.E., *Professor of Computer Science and Engineering and Professor of Electrical Engineering,* Ph.D., Illinois (Urbana-Champaign)

Eli V. Olinick, *Associate Professor of Engineering Management, Information and Systems,* Ph.D., California (Berkeley)

M. Volkan Otugen, *Professor of Mechanical Engineering and George R. Brown Chair in Mechanical Engineering,* Ph.D., Drexel

Panos E. Papamichalis, P.E., *Professor of Electrical Engineering,* Ph.D., Georgia Institute of Technology

Behrouz Peikari, P.E., *Professor of Electrical Engineering,* Ph.D., California (Berkeley)

Andrew N. Quicksall, *Assistant Professor of Environmental Science and J. Lindsey Embrey Trustee Professor,* Ph.D., Dartmouth

Peter E. Raad, P.E., *Professor of Mechanical Engineering,* Ph.D., Tennessee (Knoxville)

Dinesh Rajan, *Professor of Electrical Engineering,* Ph.D., Rice

Edmond Richer, *Associate Professor of Mechanical Engineering and Robert C. Womack Endowed Chair in Engineering,* Ph.D., SMU

S. Sevinc Sengor, *Assistant Professor of Civil and Environmental Engineering,* Ph.D., California (Davis)

Thomas F. Siems, *Senior Lecturer of Engineering Management, Information and Systems,* Ph.D., SMU

Brett Story, *Assistant Professor of Civil and Environmental Engineering,* Ph.D., Texas A&M

Jerrell T. Stracener, *Associate Professor of Engineering Management, Information and Systems,* Ph.D., SMU

Stephen A. Szygenda, P.E., *Professor of Computer Science and Engineering, Professor of Engineering Management, Information and Systems and Cecil H. Green Chair of Engineering,* Ph.D., Northwestern

Mitchell A. Thornton, P.E., *Professor of Computer Science and Engineering and Professor of Electrical Engineering,* Ph.D., SMU

Jeff Tian, P.E., *Professor of Computer Science and Engineering and Professor of Engineering Management, Information and Systems,* Ph.D., Maryland

Wei Tong, *Professor of Mechanical Engineering,* Ph.D., Brown

David A. Willis, *Associate Professor of Civil and Environmental Engineering and Associate Professor of Mechanical Engineering,* Ph.D., Purdue

Jeong Ho You, *Assistant Professor of Mechanical Engineering,* Ph.D., Illinois (Urbana-Champaign)

Emeritus Faculty

Kenneth L. Ashley, P.E., *Professor Emeritus of Electrical Engineering,* Ph.D., Carnegie Mellon

H. Charles Baker, *Professor Emeritus of Electrical Engineering,* Ph.D., Texas

Margaret H. Dunham, P.E., *Professor Emerita of Computer Science and Engineering,* Ph.D., SMU

Robert R. Fossum, *Professor Emeritus of Electrical Engineering,* Ph.D., Oregon State

Someshwar C. Gupta, P.E., *Professor Emeritus of Electrical Engineering,* Ph.D., California (Berkeley)

Richard Helgason, *Professor Emeritus of Computer Science and Engineering, Professor Emeritus of Engineering Management, Information and Systems,* Ph.D., SMU

Bijan Mohraz, P.E., *Professor Emeritus of Civil and Environmental Engineering and Professor Emeritus of Mechanical Engineering,* Ph.D., Illinois (Urbana-Champaign)

David B. Johnson, P.E., *Professor Emeritus of Mechanical Engineering,* Ph.D., Stanford

Paul F. Packman, P.E., *Professor Emeritus of Mechanical Engineering,* Ph.D., Syracuse

Cecil H. Smith, P.E., *Professor Emeritus of Civil and Environmental Engineering and Professor Emeritus of Mechanical Engineering,* Ph.D., Texas

Mandyam D. Srinath, P.E., *Professor Emeritus of Electrical Engineering,* Ph.D., Illinois (Urbana-Champaign)

Hal Watson, Jr., P.E., *Professor Emeritus of Mechanical Engineering,* Ph.D., Texas

Adjunct Faculty

Note: The list of faculty adjuncts provided here is advisory only. In any given term, a particular adjunct may not be able to teach because of other commitments. This is especially true because many of SMU's adjuncts are professionals and scholars who are in high demand.

Jane C. Ahrens, *Adjunct Lecturer of Civil and Environmental Engineering,* M.Arch., Texas (Arlington) (Gresham, Smith and Partners)

Jeffrey D. Alcantara, *Adjunct Lecturer of Computer Science and Engineering,* B.E.D., Texas A&M (Reel FX Creative Studios)

Bogdan V. Antohe, *Adjunct Professor of Mechanical Engineering,* Ph.D., SMU (MicroFab)

Karl J. Arunski, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.S.E.E., Washington (Raytheon)

Christopher L. Askew, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.S., SMU (Lockheed Martin)

John D. Baschab, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.B.A., Chicago (Technisource)

Charles W. Beall, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., Southern California

Arthur F. Beck, P.E., *Adjunct Lecturer of Civil and Environmental Engineering,* M.S., SMU (B.S.M. Engineers)

Robert L. Bell, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.E.E.E., Brigham Young (Lockheed Martin)

William D. Bell, *Adjunct Professor of Engineering Management, Information and Systems,* D.E., SMU (U.S. Department of Defense)

Eduardo Blanco, *Adjunct Professor of Computer Science and Engineering,* Ph.D., Texas (Dallas) (Lymba Corporation)

Andrew W. Blanton, *Adjunct Lecturer of Computer Science and Engineering,* M.F.A., North Texas (UNT Moebius Journal)

Samir Bougacha, P.E. *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., Texas (Parsons Brinckerhoff)

Mark K. Boyd, P.E., *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., SMU (LCA Environmental)

Timmothy Boyd, *Adjunct Lecturer of Computer Science and Engineering,* M.S., SMU (Raytheon)

William A. Bralick, Jr., *Adjunct Professor of Computer Science and Engineering,* Ph.D., Pennsylvania State (Paladin Logic Inc.)

Ann E. Broihier, *Adjunct Lecturer of Computer Science and Engineering and Adjunct Lecturer of Engineering Management, Information and Systems,* M.S., Northern Illinois (Raytheon)

Ben A. Calloni, P.E., *Adjunct Professor of Computer Science and Engineering,* Ph.D., Texas Tech (Lockheed Martin)

Hakki C. Cankaya, *Adjunct Professor of Computer Science and Engineering,* Ph.D., SMU

Robert Casagrande, *Adjunct Lecturer of Civil and Environmental Engineering,* M.B.A., SMU

Sudipto Chakraborty, *Adjunct Professor of Electrical Engineering,* Ph.D., Georgia Institute of Technology (Texas Instruments Inc.)

George W. Chollar, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., Texas Tech (The Statistical Design Institute)

Christian P. Christensen, *Adjunct Lecturer of Computer Science and Engineering,* M.S., SMU

Randall J. Clendening, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., George Washington University (Boeing)

Eric B. Cluff, *Adjunct Lecturer of Mechanical Engineering,* M.S., SMU (Abbott Labs)

Howard S. Cowin, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.S.E., California State (Northridge) (Lockheed Martin)

William S. Dahlstrom, *Adjunct Professor of Civil and Environmental Engineering,* J.D., Texas (Jackson Walker, LLP)

Weiping Dai, P.E., *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., Carnegie Mellon (Trinity Consultants)

Christopher M. Davis, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.B.A., Texas (ForeScout Technologies)

H. Elizabeth del Monte, *Adjunct Lecturer of Civil and Environmental Engineering,* M.Arch., Rice (The Return on Innovation Project)

Leven T. Deputy, P.E., *Adjunct Lecturer of Civil and Environmental Engineering,* M.S., Texas (Jacobs Engineering)

Roger O. Dickey, P.E., *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., SMU

Darin DeRita, *Adjunct Lecturer of Computer Science and Engineering,* B.S., Texas (Dallas) (Raytheon)

Theodore A. Dumas, Ph.E., *Adjunct Lecturer of Civil and Environmental Engineering,* M.S.C.E., SMU

Matthew L. Durchholz, *Adjunct Professor of Mechanical Engineering,* Ph.D., SMU (Lockheed Martin)

Carl E. Edlund, P.E., *Adjunct Lecturer of Civil and Environmental Engineering,* B.S.M.E., Maryland (U.S. Environmental Protection Agency)

Maya El Dayeh, *Adjunct Professor of Computer Science and Engineering,* Ph.D., SMU

Fawzi Elghadamsi, *Adjunct Professor of Civil and Environmental Engineering and Adjunct Professor of Mechanical Engineering,* Ph.D., SMU

Aaron L. Estes, *Adjunct Lecturer of Computer Science and Engineering,* M.S., SMU

Andrew A. Felder, *Adjunct Professor of Civil and Environmental Engineering,* J.D., New York Law School (The Arsenal Companies)

Edward Forest, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., Princeton

Dennis J. Frailey, *Adjunct Professor of Computer Science and Engineering and Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., Purdue (Raytheon, retired)

Santos Garza, *Adjunct Professor of Mechanical Engineering,* Ph.D., Texas Tech (Texas Instruments)

John R. Graham, III, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.B.A., Wright Statue (Technisource)

Anwar Hirany, P.E., *Adjunct Professor of Civil and Environmental Engineering*, Ph.D., Cornell (EPRI)

Ahmed H. H'mimy, *Adjunct Professor of Electrical Engineering*, Ph.D., SMU (Andrew Corporation)

Hossam H. H'mimy, *Adjunct Professor of Electrical Engineering*, Ph.D., SMU (Ericsson)

Michael E. Hopper, P.E., *Adjunct Professor of Engineering Management, Information and Systems*, D.E., SMU

Kenneth R. Howard, *Adjunct Lecturer of Computer Science and Engineering*, M.B.A., Saint Mary's (Improving Enterprises)

Sina Iman, *Adjunct Lecturer of Civil and Environmental Engineering*, M.S.C.E., SMU (DAL-TECH Engineering)

Kaushik Josiam, *Adjunct Professor of Electrical Engineering*, Ph.D., SMU (Samsung)

Shantanu Kangude, *Adjunct Professor of Electrical Engineering*, Ph.D., Georgia Institute of Technology (Texas Instruments)

Bhanu Kapoor, *Adjunct Professor of Computer Science and Engineering*, Ph.D., SMU (consultant/owner, Mismasic)

Mohamed M.I. Khalil, *Adjunct Professor of Computer Science and Engineering*, Ph.D., New Mexico State

Kamran Z. Khan, *Adjunct Lecturer of Computer Science and Engineering*, M.S., Texas (Dallas) (MCI WorldCom)

Clark D. Kinnaird, P.E., *Adjunct Professor of Electrical Engineering*, Ph.D., SMU (Texas Instruments)

R. Mallik Kotamarti, *Adjunct Professor of Computer Science and Engineering*, Ph.D., SMU

Paul Krier, *Adjunct Lecturer of Computer Science and Engineering*, M.S., SMU (Raytheon)

James E. Langford, *Adjunct Lecturer of Civil and Environmental Engineering*, M.Arch., Harvard (James E. Langford, Architects and Planners LLC)

Khiem V. Le, *Adjunct Professor of Electrical Engineering*, Ph.D., Southern California

Donald L. Legg, P.E., *Adjunct Lecturer of Civil and Environmental Engineering*, M.S.S.M., Akron (Bell Helicopter)

Lun Li, *Adjunct Professor of Computer Science and Engineering*, Ph.D., SMU

John I. Lipp, *Adjunct Professor of Engineering Management, Information and Systems*, Ph.D., Michigan Tech (Lockheed Martin)

D. Kall Loper, *Adjunct Professor of Computer Science and Engineering*, Ph.D., Michigan State

Paul M. Martin, P.E., *Adjunct Lecturer of Civil and Environmental Engineering*, M.S., Nebraska

Mehedy Mashnad, P.E., *Adjunct Professor of Civil and Environmental Engineering*, Ph.D., Illinois (Urbana-Champaign) (Walter P. Moore and Associates)

Matthew R. McBride, *Adjunct Lecturer of Computer Science and Engineering*, M.S., SMU (Bank of America)

Shannon K. McCall, P.E., *Adjunct Lecturer of Civil and Environmental Engineering*, M.S.E.E., Georgia Institute of Technology (Telios)

Lee D. McFearin, *Adjunct Professor of Computer Science and Engineering*, Ph.D., SMU

M. Wade Meaders, *Adjunct Lecturer of Mechanical Engineering,* M.S., SMU (Halliburton)

Freeman L. Moore, *Adjunct Professor of Computer Science and Engineering,* Ph.D., North Texas (Raytheon, retired)

William H. Muto, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., Virginia Tech (Abbott Labs)

Anurag Nagar, *Adjunct Professor of Computer Science and Engineering,* Ph.D., SMU

Padmaraj M.V. Nair, *Adjunct Professor of Computer Science and Engineering,* Ph.D., SMU

Mofid Nakhaei, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., SMU (Parson Brinckerhoff Inc.)

William P. Nanry, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., Texas (Lockheed Martin)

Nhut Nguyen, *Adjunct Professor of Electrical Engineering,* Ph.D., Tokyo (Samsung)

David J. Nowacki, *Adjunct Lecturer of Mechanical Engineering,* M.B.A., M.S., Louisiana State

Jennifer A. O'Brien, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., North Texas

Robert S. Oshana, *Adjunct Lecturer of Computer Science and Engineering and Adjunct Lecturer of Engineering Management, Information and Systems,* M.S., SMU (Object Space Inc.)

David A. Peters, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.S., Texas (Dallas)

John J. Pfister, *Adjunct Lecturer of Computer Science and Engineering,* M.C.S., Texas A&M (Texas Instruments, retired)

Oscar K. Pickels, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.B.A., SMU

Sally R. Pinon, *Adjunct Lecturer of Civil and Environmental Engineering,* M.A., Texas (Arlington)

Jon C. Piot, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.B.A., Harvard (Technisource)

Leonid Popokh, *Adjunct Lecturer of Computer Science and Engineering,* M.S., Texas (Dallas)

Sohail Rafiqi, *Adjunct Lecturer of Computer Science and Engineering,* M.S., SMU

Jon D. Rauscher, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., Colorado State (U.S. Environmental Protection Agency)

Mohamed O. Rayes, *Adjunct Professor of Computer Science and Engineering,* Ph.D., Kent State

Luis G. Resendis, *Adjunct Lecturer of Computer Science and Engineering,* M.S., SMU

James B. Rodenkirch, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.S., SMU

Christopher A. Rynas, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.S.E., Texas Tech (Raytheon)

Kaiser Saeed, *Adjunct Lecturer of Electrical Engineering,* M.B.A., Dallas (IBM)

Mark E. Sampson, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.S., Southern California (UGS)

Nandlal M. Singh, *Adjunct Professor of Engineering Management, Information and Systems,* D.E., SMU (MinMax Technologies)

Stephen C. Skinner, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., SMU (Bell Helicopter)

Gheorghe M. Spiride, *Adjunct Professor of Engineering Management, Information and Systems and Adjunct Professor of Computer Science and Engineering,* Ph.D., SMU (Nortel Networks)

D. Blair Spitzberg, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., Texas (U.S. Nuclear Regulatory Commission)

Kamakshi Sridhar, *Adjunct Professor of Electrical Engineering,* Ph.D., Massachusetts Institute of Technology (Alcatel-Lucent)

John L. Stanley, *Adjunct Lecturer of Civil and Environmental Engineering,* M.S., SMU (FACServices Inc.)

Bennett Stokes, *Adjunct Professor of Civil and Environmental Engineering,* J.D., Texas

Hung-Ming (Sue) Sung, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., Vanderbilt

Patricia A. Taylor, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., SMU (U.S. Environmental Protection Agency)

Kenneth T. Thomas, *Adjunct Lecturer of Civil and Environmental Engineering,* M.S., Amberton

Allen D. Tilley, *Adjunct Lecturer of Mechanical Engineering,* M.B.A., SMU

Philip K. Turner, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., North Texas (U.S. Environmental Protection Agency)

Raymond E. Van Dyke, *Adjunct Professor of Computer Science and Engineering,* J.D., North Carolina (Chapel Hill)

Russell A. Vacante, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., State University of New York (Buffalo) (RMS Partnership Inc.)

John W. Via, III, *Adjunct Professor of Engineering Management, Information and Systems,* D.E., SMU (Alcon Laboratories)

Andrew K. Weaver, *Adjunct Lecturer of Mechanical Engineering,* M.A., Navy; M.P.A., Troy State

James R. Webb, *Adjunct Lecturer of Mechanical Engineering,* M.B.A., Dallas

Dan Wittliff, P.E., *Adjunct Lecturer of Civil and Environmental Engineering,* M.B.A., Oklahoma (GDS Associates Inc.)

Scott P. Woodrow, P.E., *Adjunct Lecturer of Civil and Environmental Engineering,* M.S., SMU (Dallas Cowboys)

Timothy D. Woods, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., SMU (Lockheed Martin)

John R. Yarrow, *Adjunct Lecturer of Engineering Management, Information and Systems,* M.S., North Texas (XO Communications)

Rumanda K. Young, *Adjunct Professor of Civil and Environmental Engineering,* Ph.D., Texas (Arlington) (U.S. Army Corps of Engineers)

Hossam A. Zaki, *Adjunct Professor of Engineering Management, Information and Systems,* Ph.D., SMU (Zilliant)

Jessie Marshall Zarazaga, *Adjunct Lecturer of Civil and Environmental Engineering,* M.Arch., Cambridge