Lyle School of Engineering

GENERAL INFORMATION

The Lyle School of Engineering traces its roots to 1925, when the Technical Club of Dallas, a professional organization of practicing engineers, petitioned SMU to fulfill the need for an engineering school in the Southwest. In response to the club's request, the Lyle School of Engineering began one of the first cooperative education programs in the United States, a program that continues today to put engineering students to work on real technical projects.

Included in the Lyle School of Engineering curricula are programs in civil engineering, computer engineering, computer science, electrical engineering, environmental engineering, mechanical engineering and management science. In 2000, the Lyle School of Engineering introduced Engineering and Beyond, a variety of programs designed to provide a generous mix of a traditional engineering curriculum and selected leadership coursework. This leadership coursework is designed to train engineering students for futures in management, entrepreneurship and beyond.

Corporate support for the Engineering School has generated a remarkable array of equipment and laboratories. Recent additions include the AT&T Mixed Signals Lab, the Texas Instruments Digital Signal Processing Lab, the Procter and Gamble Biomedical Research Lab, and the Nokia Wireless Communication Lab. Other laboratories include the Laser Micromachining Lab, the Nanoscale Electro-thermal Science Lab and the Enterprise Systems Design Laboratory. In addition, the Lyle School is the home of the Research Center for Advanced Manufacturing and the National Science Foundation Industry/University Cooperative Research Center for Lasers and Plasmas for Advanced Manufacturing. RCAM provides the intellectual foundation for industry to collaborate with faculty and students to resolve generic, long-range challenges, thereby producing the knowledge base for steady advances in technology and their speedy transition to the marketplace. CLAM addresses a number of research and development issues related to laser/plasma-aided manufacturing processes. The Dallas area's national prominence in high technology and research has been beneficial to the Lyle School of Engineering and its students.

PROFESSIONAL ENGINEERING LICENSURE

All senior-year engineering students are encouraged to take the first part of the examination for professional engineering licensure in the state of Texas. This is known as the *Fundamentals of Engineering Examination* and is administered on campus once annually in early April. The Lyle School of Engineering provides a review course to prepare students for the exam. Application forms for the examination may be obtained from the Office of Undergraduate Studies.

PROGRAM INFORMATION

All programs of education and research in engineering are conducted through the Lyle School of Engineering. The school is organized into the following departments:

Civil and Environmental Engineering (CEE)*
Computer Science and Engineering (CSE)
Electrical Engineering (EE)
Engineering Management, Information and Systems (EMIS)
Mechanical Engineering (ME)

** CEE courses will be listed as ENCE courses in Access.SMU until spring 2011.*

The Lyle School of Engineering offers curricula leading to the Bachelor's degree in the following programs (the department responsible for each program is indicated in parentheses):

Civil Engineering (CEE)*
Computer Engineering (CSE)
Computer Science (CSE)
Electrical Engineering (EE)
Environmental Engineering (CEE)*
Management Science (EMIS)
Mechanical Engineering (ME)

** CEE courses will be listed as ENCE courses in Access.SMU until spring 2011.*

Each curriculum is under the jurisdiction of the faculty of the department in which the program is offered.

The Lyle School of Engineering also offers graduate programs toward the degrees of Master of Science, Doctor of Engineering and Doctor of Philosophy.

The departments are the Lyle School of Engineering's basic operating and budgetary units. Each department is responsible for the development and operation of its laboratories at all levels of activity and for all purposes; for the content, teaching and scheduling of its academic courses; and for the conduct of research programs. The chief administrative officer of each department is the department chair, who reports directly to the dean.

Every effort has been made to include in this publication information that, at the time of preparation for printing, most accurately represents SMU within the context in which it was offered. The provisions of this publication are not, however, to be regarded as an irrevocable contract between the student and SMU. The University reserves the right to change or terminate, at any time and without prior notice, any provision or requirement, including but not limited to, policies, procedures, charges, academic programs and distance-education courses.

More information on the Lyle School of Engineering and its programs is available at www.engr.smu.edu.

UNDERGRADUATE ENGINEERING INTERNSHIP PROGRAM

This program is intended to allow students who enroll as full-time students to include a minimum of three terms of professional work experience during the course of their study. Students must have obtained junior-level class status prior to participating in work experience. Students cannot simultaneously enroll in a full-time load of coursework and participate in a full-time work experience. A "full-time" course of study is defined as 12 or more credit hours per term, and a "full-time" work experience is defined as a minimum of 37.5 hours worked per week. In order to maintain satisfactory academic achievement, students enrolled in a full-time course load shall not work more than a maximum of 20 hours a week. Students who are actively participating in a full-time work experience shall not enroll in more than nine credit hours per term. Zero hours of credit will be awarded for each term of internship. Participation in this program will not jeopardize the full-time status of international students.

Students who wish to participate in this program will need to:

- Receive an internship job offer relating to their major.
- Provide a job description to the Office of Undergraduate Professional Experience Programs.
- Complete the Undergraduate Engineering Internship Program Agreement form.
- Obtain the following approvals: faculty adviser, department chair, director of Undergraduate Professional Experience Programs, International Student Office (for all international students).

Once the necessary approvals are obtained, the student must register for the Undergraduate Internship Program course that is designated by the student's department (CEE 5050, CSE 5050, EE 5050, EMIS 5050, ME 5050).

Upon conclusion of the work assignment, the student must submit a report outlining the activities and duties of the internship within two weeks of the end of the term or at the end of the internship, whichever comes first. The student will submit a copy of the report to the faculty adviser, the International Office (if applicable) and the director of Undergraduate Professional Experience Programs of the Lyle School of Engineering. The director of Undergraduate Professional Experience Programs, in consultation with the student's adviser, will assess the report and recommend a grade of S (Satisfactory) or U (Unsatisfactory) to the associate dean for Academic Affairs within two weeks of receiving the report. The student's work experience will be validated and recognized on the permanent transcript.

Cooperative Education

The history of the Lyle School of Engineering at SMU demonstrates a commitment to the concept of cooperative education. When the Lyle School of Engineering was established in 1925, it already had a close relationship with the Technical Club of Dallas. Members of this group owned factories and engineering consulting firms and wanted to participate in the training and development of their incoming employees. The Technical Club asked SMU to include the Cooperative Education Program in the original design of the school.

SMU was one of the first universities in the Southwest to adopt this concept of practical education. From 1925 to 1965, all Lyle School of Engineering undergraduate students participated in the SMU Co-op Program. Since 1965, the program has been optional.

The SMU Co-op Program is designed so that each student can enhance his or her education and career by receiving professional training while alternating terms of classroom instruction. Participation in the program allows students to:

- Confirm that they like working in their major.
- Discover the kind of work they like within their major.
- Establish a professional reputation.
- Earn the cumulative equivalent of one year of a new graduate's starting salary before graduation.
- Gain invaluable work experience when competing for full-time jobs upon graduation.

HOW THE COOPERATIVE PROGRAM OPERATES

Entry into the SMU Co-op Program is typically offered at the spring term of the sophomore year or the fall term of the junior year during the student's academic progression. The terms of entry are shown below:

	5 Work Terms		
PLAN A	*Fall*	*Spring*	*Summer*
First Year	SMU	SMU	Free
Sophomore	SMU	SMU	Industry
Junior	Industry	SMU	Industry
Senior 4th	SMU	Industry	Industry
Senior 5th	SMU	SMU	

	4 Work Terms		
PLAN B	*Fall*	*Spring*	*Summer*
First Year	SMU	SMU	Free
Sophomore	SMU	SMU	Free
Junior	Industry	SMU	Industry
Senior 4th	SMU	Industry	Industry
Senior 5th	SMU	SMU	

Students who want to participate in the SMU Co-op Program should begin the application process two terms before their anticipated first work term. The application process includes attending Co-op Orientation (preferably during the first year), receiving interview skills training, learning the job search process and completing a computerized application. The program director guides students through each step of the process.

Each applicant receives quality advising from the program's associate director. A direct result of advising is that the student gains a better understanding of individual options and a strategy for pursuing those options. The application process requires one or two hours per week for almost two terms. The process normally results in an offer of employment beginning in the spring term during the sophomore year or the fall term of the junior year.

Who May Apply?

Any Lyle School of Engineering undergraduate student in good standing who has enough time remaining before graduation to alternate at least three times between terms of full-time work and terms of full- time school may apply for admission into the program. Transfer students must be admitted and accepted at SMU.

When to Apply

Many students choose to begin the application process during the first term of their first year. This head start is especially beneficial for students planning to participate in fraternity/sorority recruitment during the second term of their first year.

Students should apply two or more terms before the work term begins. The first of these terms is for preparation; the second is for applying/interviewing with companies.

POLICIES OF THE COOPERATIVE ENGINEERING EDUCATION PROGRAM

Since 1925, the Lyle School of Engineering has created and maintained numerous corporate relationships. Many factors contribute to these relationships, including the quality of SMU's academics and research, the achievements of alumni, and SMU's close proximity to high-tech corporations.

Each SMU co-op student directly benefits from the program's strong corporate relationships and bears an obligation to preserve these relationships by following the Co-op Program Undergraduate Student Agreement. The agreement balances the student's individual needs with the long-term goal of maintaining the program's corporate relationships for future SMU students.

The terms of the program include, but are not limited to, the following:

- Students must maintain good standing with SMU and their employer at all times.
- All training jobs must be approved in advance by the SMU Co-op Program associate director.
- Before each work term begins, each undergraduate student in the program must enroll in the appropriate program course for the term when they work.
- SMU charges no fees or tuition for these courses. Each course is graded as pass/fail by the program's associate director. The courses do not count toward graduation. The course numbers for each work term are, respectively, SS 1099, 2099, 3099, 4099, 5099, 6099.
- Students enroll at SMU each term, including summers, once they begin the program's rotation between work and school.
- Co-op students take full-time class loads at SMU during alternating school terms.
- Co-op students do not work part-time for the employer during school terms.
- Co-op students complete all work terms with the same company.
- Once a student accepts a training job, the student may switch jobs within the sponsoring company with the approval of the company.
- Each student in the program completes his or her originally planned number and sequence of alternating work terms. The term of graduation must be a term of full-time study at SMU.
- Each student in the program accepts responsibility for knowing and following all SMU Co-op Program regulations and those of the participating employer.

CO-OP CERTIFICATE

Co-op students who complete all of their originally planned and scheduled SMU Co-op Program work terms in good standing with the University and the SMU Co-op Program Office receive a Cooperative Education Program Certificate to coincide with graduation.

For additional information, contact the associate director of the SMU Co-op Program at 214-768-1845 or by e-mail at smucoop@engr.smu.edu.

Admission

For detailed information regarding Southern Methodist University's admission requirements, regulations and procedures, see the University Admission section of this catalog.

Prospective students interested in undergraduate degrees in engineering apply for undergraduate admission to SMU as first-year or transfer students through the Office of Admissions, Southern Methodist University, PO Box 750181, Dallas TX 75275-0181.

All first-year applicants admitted to SMU initially enter Dedman College. For students interested in majoring in engineering, a personal interview with the Office of Admission and the Lyle School of Engineering Undergraduate Enrollment Office is highly recommended. The Lyle School of Engineering Office of Undergraduate Student Experience and Enrollment Management can be reached at 214-768-3041.

HIGH SCHOOL PREPARATION

Because of the high standards of the Lyle School of Engineering and the rigorous character of its curricula, it is essential that the entering student be well prepared in basic academic subjects in high school.

The usual high school preparation for entrance into SMU and study in engineering includes the following courses:

English	4 units
Mathematics	4–5 units
Physics, chemistry, biology	At least 3 units
Social studies	2 units
Foreign language	2 units
Computer programming	1 unit

However, a minimum of 15 academic units is required for admission. The courses listed above, with the exception of foreign languages, are recommended but are not required.

Most recently, students admitted to SMU with the intention of majoring in engineering were the most competitive applicants. To be successful in SMU engineering programs, the student *should* have the following academic strengths:

1. Enrollment in an appropriate program of study in high school, as outlined above.
2. Rank in the upper third of his or her graduating high school class.
3. A minimum SAT composite score of 1150 with at least a 600 math score. Equivalent scores for the ACT exam may also be submitted.

These guidelines should assist students interested in studying engineering at SMU.

ADMISSION TO ADVANCED STANDING

Admission From Dedman College and Other Schools Within SMU

After completion of the first year, students are admitted to the Lyle School of Engineering through an interschool transfer. These transfers are approved by the appropriate department chair and the associate dean of the Lyle School of Engineering. For admission, a student must have completed 24 credit hours and must demonstrate the ability to achieve academic success in engineering or applied science by attaining a 2.0 or higher cumulative GPA. For admission into the civil engineering, computer engineering, computer science, electrical engineering, environmental engineering, management science or mechanical engineering program, a 2.5 or higher GPA is required in the following courses: ENGL 1301 and ENGL 1302 or equivalent, MATH 1337 and MATH 1338, and a minimum of two courses as follows for each Lyle major:

Civil engineering	**CEE 1302, CEE/ME 2310, CSE 1341**
Computer engineering	**CSE 1341, 1342**
Computer science	**CSE 1341, 1342**
Electrical engineering	**EE 1322, 1382**
Environmental engineering	**CEE 1302, CEE/ME 2310, CSE 1341**
Management science	**CSE 1341, 1342** and a grade of *C* or better in all subset courses
Mechanical engineering	**ME 1202 and 1102, ME 1305 or CSE 1341, ME/CEE 2310**

With the exception of courses repeated using the First-Year Repeat Policy, all attempts of subset courses will be used in computing the subset GPA. The subset GPA for students who have Advanced Placement or International Baccalaureate credit is based upon the remaining graded subset courses. Current University grading policy, as summarized under Academic Forgiveness in the Policies and Procedures section of this catalog, permits forgiveness of academic work taken 10 or more years prior to the term of admission. Academic work forgiven under this policy will not be included in the subset GPA.

Admission by Transfer From Another Institution

An undergraduate at a junior college, college or university may apply for admission to the Lyle School of Engineering. Admission will be granted provided the prior academic records and reasons for transfer are acceptable to the Lyle School of Engineering. Transfer credit will be awarded in courses that have identifiable counterparts in curricula of the Lyle School of Engineering, provided they carry grades of *C*- or better. Transfer students will be expected to meet requirements equivalent to students admitted from Dedman College and other schools within SMU.

Transfer credit is awarded only for work completed at institutions that have regional or comparable accreditation. Because of the 60-term-hour SMU credit requirement for a Bachelor’s degree, there is a limit on the total amount of credit that may be applied toward a Lyle School of Engineering degree.

GRADUATION REQUIREMENTS FOR BACCALAUREATE DEGREES

Graduation from the Lyle School of Engineering with a Bachelor's degree requires that the following standards of academic performance be met:

1. A passing grade must be received in every course in the prescribed curriculum.
2. An overall GPA of 2.0 or better must be attained in all college and university courses.
3. An overall GPA of 2.0 or better must be attained in all coursework attempted for the degree through enrollment at SMU.
4. An overall GPA of 2.0 or better must be attained in all coursework attempted for the degree in the major field of study.
5. A minimum of 122 term hours of credit must be attained, including 35–41 hours in the General Education Curriculum, and the requirements met for a major in engineering or applied science.

SMU and Lyle Credit Requirements

For graduation from the Lyle School of Engineering, 60 term credit hours must be earned as SMU credit, including 30 term credit hours in the major department or interdisciplinary program. Of the last 60 term credit hours earned toward a degree, 45 must be completed through enrollment in courses offered by the faculty of the Lyle School of Engineering. Exceptions to this requirement will be made only under unusual circumstances at the discretion of the Lyle School of Engineering faculty.

The Major

A candidate for a degree must complete the requirements for a major in one of the departments of the Lyle School of Engineering. The major requirements of each department and program are stated in the next section. The applicable requirements of the major are those in effect during the academic year of matriculation, or those of a subsequent academic year. Coursework counting toward a major may not be taken pass/fail. Majors must be officially declared (or changed) through the Office of Undergraduate Studies.

GENERAL EDUCATION PROGRAM

All SMU undergraduate students have a common college requirement that is designed to assure them of a broad liberal education regardless of how specialized their majors might be. This requirement is designed to help each student learn to reason and think for oneself; become skilled in communicating meaning and in understanding it; understand something about both the social and the natural worlds and one's own place and responsibilities in them; and understand and appreciate human culture and history in their various forms, including religion, philosophy and the arts.

The general education requirements for the Lyle School of Engineering program must follow the requirements of the University. See the General Education Curriculum section of this catalog for more information.

Programs of Study

The Lyle School of Engineering offers the following degrees:

Bachelor of Science in Civil Engineering
Bachelor of Science in Computer Engineering
Bachelor of Science in Electrical Engineering
Bachelor of Science in Environmental Engineering
Bachelor of Science in Mechanical Engineering
Bachelor of Science (Computer Science)
Bachelor of Science (Management Science)
Bachelor of Arts (Computer Science)

Engineering work can be classified by function, regardless of the branch it is in, as follows: research, development, design, production, testing, planning, sales, service, construction, operation, teaching, consulting and management. The function fulfilled by an engineer results in large measure from personal characteristics and motivations, and only partially from his or her curriculum of study. Nonetheless, although engineering curricula may be relatively uniform, their modes of presentation tend to point a student toward a particular large class of functions. Engineering curricula at SMU aim generally at engineering functions that include research, development, design, management and teaching – functions ordinarily associated with additional education beyond the Bachelor's degree.

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

DESCRIPTION OF COURSES

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: 1 – first year, 2 – sophomore, 3 – junior, 4 – senior, and 5 – senior. The second digit denotes the term hours associated with the course. The last two digits specify the course numbers. Thus, CSE 4381 denotes a course offered by the Department of Computer Science and Engineering at the senior (4) level, having three term hours, and with the course number 81. 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
ME – Department of Mechanical Engineering
SS – Center for Special Studies

CIVIL AND ENVIRONMENTAL ENGINEERING

Professor Jeffrey W. Talley, **Chair**

Professors: Bijan Mohraz, Jeffrey W. Talley. **Associate Professors:** Khaled Abdelghany, Paul Krueger (Mechanical Engineering), David A. Willis (Mechanical Engineering). **Research Associate Professor:** Alfredo Armendariz. **Assistant Professors:** Usama El Shamy, Andrew N. Quicksall. **Senior Lecturer:** Roger O. Dickey. **Adjunct Faculty:** Jane Ahrens, Arthur F. Beck, Samir Bougacha, Mark K. Boyd, Robert R. Casagrande, William S. Dahlstrom, Weiping Dai, Betsy del Monte, Leven T. Deputy, James Duke, John H. Easton, Carl Edlund, Fawzi Elghadamsi, Andrew Felder, Edward Forest (Retired Chair), Kathryn C. Hawkins, Anwar Hirany, Louis Hosek, Ron Jackson, Timothy L. Jacobs, James E. Langford, Donald L. Legg, Paul Martin, Shannon K. McCall, Jennifer O'Brien, Jon D. Rauscher, Cecil Smith (Professor *Emeritus*), D. Blair Spitzberg, John Stanley, Bennett Stokes, Patricia A. Taylor, Kenneth T. Thomas, Philip K. Turner, Dan Wittliff, Scott Woodrow, Rumanda K. Young.

Undergraduate programs within the Department of Civil and Environmental Engineering educate and train leaders in the fields of environmental protection, resource management, construction and engineering design. Programs are tailored to the individual needs and interests of CEE students, so that students with interests in studying global climate change, protecting the quality of the drinking water, or designing the next generation of high-rise buildings or smart highways receive the training they need to excel in their careers. As part of their education, CEE students are paired with CEOs, business leaders, professional engineers, Environmental Protection Agency directors or corporate attorneys in a mentoring program designed to propel students into promising 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 the population and the environment. Civil and environmental engineering functioned as a single integrated discipline in the early 1900s 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.

Environmental Engineering Program

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 pollution control. In addition, modern manufacturing, both domestic and worldwide, is focused on using recycled and natural materials to fabricate products that are competitive in the marketplace 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 peoples of the world.

The educational objectives of the environmental engineering program are consistent with the missions of the Civil and Environmental Engineering Department, the Lyle School of Engineering, and the overall institutional mission of SMU, and were determined based on the needs of the program's various constituencies. The program prepares graduates to achieve the following educational objectives during the medium term of their professional careers:

1. Assume important leadership positions in a globally competitive world.
2. Fully participate either as engineering designers or managers in the public or private sectors.
3. Pursue advanced academic or professional degrees in engineering, medicine, law, business or public policy.
4. Licensing as professional engineers.

The environmental engineering program prepares graduates for professional practice and advanced study through a focus in the following areas: 1) water supply and resources, 2) environmental systems and process modeling, 3) environmental chemistry, 4) wastewater management, 5) solid waste management, 6) hazardous waste management, 7) atmospheric systems and air pollution control, and 8) environmental and occupational health.

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 mission of the civil engineering program is to prepare graduates for professional practice and advanced studies by focusing on the following areas: structural engineering, geotechnical engineering, transportation planning, environmental engineering and water resources. Graduates will be equipped with the skills and knowledge necessary to be fully participatory members of civil engineering teams and contributors to civil engineering efforts conducted within the evolving global economy.

The mission and educational objectives of the civil engineering program are consistent with the missions of the Civil and Environmental Engineering Department, the Lyle School of Engineering, and the overall institutional mission of SMU, and were determined based on the needs of the program's various constituencies. The program prepares graduates to achieve the following educational objectives during the medium term of their professional careers:

1. Assume important leadership positions in a globally competitive world.
2. Fully participate either as engineering designers or managers in the public or private sectors.
3. Pursue advanced academic or professional degrees in engineering, medicine, law, business, or public policy.
4. Licensing as professional engineers.

Degrees Offered

The Civil and Environmental Engineering Department offers undergraduate degrees as follows:

Bachelor of Science in Environmental Engineering
Bachelor of Science in Environmental Engineering and Bachelor of Science in Mathematics (dual degrees)

Bachelor of Science in Environmental Engineering With a Premedical Specialization
Bachelor of Science in Civil Engineering
Bachelor of Science in Civil Engineering and Bachelor of Science in Mathematics (dual degrees)

The undergraduate programs in environmental engineering and civil engineering are accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

Both the civil and environmental engineering programs are designed to prepare students for the Fundamentals of Engineering Examination, the first step toward licensure as a professional engineer. Engineering design is integrated throughout the civil and environmental engineering curricula, each culminating in a major design experience based on the knowledge and skills acquired in earlier coursework. In their senior year, the department's engineering students are required to take two terms of design where teams of two to four students work closely on practical projects sponsored by industry and government. Senior design projects incorporate engineering standards and realistic constraints including most of the following considerations: economic, environmental, sustainability, manufacturability, ethical, health and safety, social, and political. The department's engineering curricula ensure that students develop an understanding of the concepts of professional engineering practice, including ethical responsibilities, effective oral and written communication, engineering management and entrepreneurship, participation on multidisciplinary teams, procurement, bidding, the interaction of design and construction professionals, professional licensing, and the need for lifelong learning.

Departmental Facilities

CEE departmental offices and instructional and research laboratories are located in the new, state-of-the-art J. Lindsay Embrey Building, certified as a Leadership in Energy and Environmental Design Gold Building in LEED's internationally recognized green building certification program. Environmental teaching and research laboratories include dedicated space for air quality and meteorology, industrial hygiene, environmental microbiology and water quality. The air quality and meteorology laboratory includes modern airflow, pressure and volume measurement instrumentation. The industrial hygiene laboratory includes an inventory of the latest personal monitoring equipment for assessing occupational exposure to a variety of industrial process stressors including: asbestos, noise, total and respirable dust, metals, radiation, and heat stress.

The air quality/meteorology and water quality laboratories have sophisticated analytical capabilities for performing chemical analyses of air samples and for assessing the quality of water supplies and wastes and the effectiveness of water and waste treatment procedures. Major equipment includes an Agilent gas chromatography and mass spectrometry unit for identifying and measuring organic compounds; a Dionex ion chromatography unit for measuring important ions in the environment, such as nitrate, nitrite and perchlorate; two Hewlett-Packard gas chromatographs; and a state-of-the-art UV-VIS machine that can perform many colorimetric analyses as well as study compounds that have a chromaphore. Other miscellaneous equipment includes continuous ambient air monitoring devices, a UV/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. An autoclave and UV light reader support basic engineering microbiological work.

Civil engineering teaching and research laboratories include dedicated space for mechanics of materials and structural engineering, hydraulics and hydrology, soil mechanics and geotechnical engineering, 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 (e.g., undershot weir, rotary undershot gate, and sharp and broad-crested weirs), a basic hydraulics bench for fundamental fluid mechanics experiments (e.g., hydrostatic pressure forces, Bernoulli's theorem and pipe friction losses), and a hydrology study system for hydrology experiments (e.g., 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 with personal computers, high-resolution color monitors and laser printers for use by the department's students. Computers in 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 to 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.

Bachelor of Science in Environmental Engineering

Curriculum Requirements		*Term Credit Hours*
College Requirements:	Humanities, Social Sciences and SMU required courses	23
Mathematics/Statistics:	MATH 1337, 1338, 2339, 2343; STAT 4340 or 5340	15
Sciences:	Biology: CEE 5418 Engineering Microbiology Chemistry: CHEM 1113, 1114, 1303, 1304 Earth Science: CEE 1331 Meteorology Physics: PHYS 1105, 1106, 1303, 1304	23
Engineering Science and Design:	Computer Science and Engineering: CSE 1340 or 1341 Civil/Mechanical Engineering: CEE 2310, 2331, 2342	12
Environmental Engineering and Design:	CEE 1302, 2304, 2421, 3323, 3341, 3431, 3451, 4380, 4381, 5317, 5354, 5372	39
Environmental Technical Electives:	Selected with adviser approval	6
Engineering Leadership:	CEE 3302 and two of CSE 4360, EMIS 3308 and 3309	9
	Minimum total hours required	**127**

Bachelor of Science in Environmental Engineering
(Premedical Specialization)

Curriculum Requirements		*Term Credit Hours*
College Requirements:	Humanities, Social Sciences and SMU required courses	23
Mathematics/Statistics:	MATH 1337, 1338, 2339, 2343; STAT 4340 or 5340	15
Sciences:	Biology: BIOL 1401, 1402, 3304, 3350 Chemistry: CHEM 1113, 1114, 1303, 1304, 3117, 3118, 3371, 3372 Earth Science: CEE 1331 Meteorology Physics: PHYS 1105, 1106, 1303, 1304	41
Engineering Science and Design:	Computer Science and Engineering: CSE 1340 or 1341 Civil/Mechanical Engineering: CEE 2310, 2331, 2342	12
Environmental Engineering and Design:	CEE 1302, 2304, 2421, 3323, 3341, 3431, 3451, 4380, 4381, 5354, 5372	36
Environmental Technical Electives:	Selected with adviser approval	6
	Minimum total hours required	**133**

Bachelor of Science in Environmental Engineering and Bachelor of Science in Mathematics

Curriculum Requirements		*Term Credit Hours*
College Requirements:	Humanities, Social Sciences and SMU required courses	23
Mathematics/Statistics:	MATH 1337, 1338, 2339, 2343, 3315, 3337 and two advanced MATH electives selected with math adviser approval; STAT 4340 or 5340	27
Sciences:	Biology: CEE 5418 Engineering Microbiology Chemistry: CHEM 1113, 1114, 1303, 1304 Earth Science: CEE 1331 Meteorology Physics: PHYS 1105, 1106, 1303, 1304	23
Engineering Science and Design:	Computer Science and Engineering: CSE 1340 or 1341 Civil/Mechanical Engineering: CEE 2310, 2331, 2342	12
Environmental Engineering and Design:	CEE 1302, 2304, 2421, 3323, 3341, 3431, 3451, 4380, 4381, 5317, 5354, 5372	39
Advanced Environmental/ Mathematics Electives:	Choose two from: CEE 5331, 5332, 5334; ME 5336	6
	Minimum total hours required	**130**

Bachelor of Science in Civil Engineering

Curriculum Requirements		*Term Credit Hours*
College Requirements:	Humanities, Social Sciences and SMU required courses	23
Mathematics/Statistics:	MATH 1337, 1338, 2339, 2343; STAT 4340 or 5340	15
Sciences:	Chemistry: CHEM 1113, 1114, 1303, 1304 Earth Science: GEOL 1301 or 1315 Physics: PHYS 1105, 1106, 1303, 1304	19
Engineering Science and Design:	Computer Science and Engineering: CSE 1340 or 1341 Civil/Mechanical Engineering: CEE 2320, 2331, 2342/2142	13
Civil Engineering and Design:	CEE 1302, 2304, 2310, 2340/2140, 3323, 3350, 4350, 4351, 4380, 4381, 4385, 5354, 5372, 5378	43
Civil Engineering Technical Electives:	Selected with adviser approval	6
Engineering Leadership:	CEE 3302 and one of CSE 4360, EMIS 3308 and 3309	6
	Minimum total hours required	**125**

Bachelor of Science in Civil Engineering and Bachelor of Science in Mathematics

Curriculum Requirements		*Term Credit Hours*
College Requirements:	Humanities, Social Sciences and SMU required courses	23
Mathematics/Statistics:	MATH 1337, 1338, 2339, 2343, 3315, 3337 and two advanced MATH electives selected with math adviser approval; STAT 4340 or 5340	27
Sciences:	Chemistry: CHEM 1113, 1114, 1303, 1304 Earth Science: GEOL 1301 or 1315 Physics: PHYS 1105, 1106, 1303, 1304	19
Engineering Science and Design:	Computer Science and Engineering: CSE 1340 or 1341 Civil/Mechanical Engineering: CEE 2320, 2331, 2342/2142	13
Civil Engineering and Design:	CEE 1302, 2304, 2310, 2340/2140, 3323, 3350, 4350, 4351, 4380, 4381, 4385, 5354, 5372, 5378	43
Advanced Civil Engineering/ Mathematics:	Choose two from: CEE 5361, CEE 5364; ME 5322	6
	Minimum total hours required	**131**

Minor in Environmental Engineering

For approval of a minor in environmental engineering, the student should consult the Civil and Environmental Engineering Department. A minimum of 15 term credit hours in environmental engineering courses is required. One example of an approved set of courses that provides a broad introduction to environmental engineering is:

CEE 2304 Introduction to Environmental Engineering and Science
CEE 2421 Aquatic Chemistry
CEE 3431 Fundamentals of Air Quality I
CEE 4329 Design of Water and Wastewater Systems
CEE 5354 Environmental Engineering Principles and Processes

Based on the student's interests and background, other sets of environmental engineering courses may be substituted with the approval of the Civil and Environmental Engineering Department.

Minor in Civil Engineering

For approval of a minor in civil engineering, the student should consult the Civil and Environmental Engineering Department. A minimum of 15 term credit hours in civil engineering courses is required. The following is an example of an approved set of courses, totaling 16 term credit hours, that provides an emphasis on structural analysis and design:

CEE 2310 Statics
CEE 2340/2140 Mechanics of Deformable Bodies/Mechanics of Materials Laboratory
CEE 3350 Structural Analysis
CEE 4350 Design of Steel Structures
CEE 4385 Soil Mechanics and Foundations

Based on the student's interests and background, other sets of civil engineering courses may be substituted with the approval of the Civil and Environmental Engineering Department.

The Courses (CEE)*

* **NOTE:** *CEE courses will be listed as ENCE courses in Access.SMU until spring 2011.*

1301. Environment and Technology: Ecology and Ethics. Students are introduced to the economic, engineering, ethical, political, scientific and social considerations of environmental decision-making and management. Local, regional and global topics will be examined. Students will take off-campus field trips.

1302. Introduction to Civil and Environmental Engineering. Students are introduced to the disciplines of civil and environmental engineering. Many of the hallmarks of modern society, including high-rise office buildings, increased lifespan, the virtual elimination of numerous diseases, and reliable long-distance and public transportation systems are the result of work by environmental and civil engineers. Likewise, many problems presently confronting developing nations, including housing supply, food production, air and water pollution, spread of disease, traffic congestion, and flood control will be solved by environmental and civil engineers. The course emphasizes fundamental science, engineering and ecological principles and encourages the development of analytical and critical thinking skills with real-world problem solving.

1331. Meteorology. Meteorology is the science and study of the Earth's atmosphere and its interaction with the earth and all forms of life. Meteorology seeks to understand and predict the properties of the atmosphere, weather and climate from the surface of the planet to the edge of space. Appropriate for all interested undergraduates.

1378. Transportation Infrastructure. An overview and definitions of infrastructure elements with concentration on transportation. Principles of infrastructure planning and management. Congestion and performance measures. Relationship with economy, environment, safety, homeland security and technology.

2140 (ME 2140). Mechanics of Materials Laboratory. Experiments in mechanics of deformable bodies, to complement CEE 2340. Simple tension tests on structural materials, simple shear tests on riveted joints, stress and strain measurements, engineering and true stress, engineering and true strain, torsion testing of cylinders, bending of simple supported beams, deflection of simply supported beams, buckling of columns, strain measurements of pressure vessels, Charpy impact tests, and effect of stress concentrators. *Corequisite or prerequisite:* CEE 2340.

2142 (ME 2142). Fluid Mechanics Laboratory. One three-hour laboratory session per week. Experiments in fluid friction, pumps, boundary layers and other flow devices to complement lecture material of CEE 2342. One credit hour. *Corequisite or prerequisite:* CEE 2342.

2304. Introduction to Environmental Engineering and Science. Introduction to a scientific and engineering basis for identifying, formulating, analyzing and understanding various environmental problems. Material and energy balances are emphasized for modeling environmental systems and processes. Although traditional materials in air and water pollution are examined, emphasis is placed on contemporary topics such as hazardous waste, risk assessment, groundwater contamination, global climate change, stratospheric ozone depletion and acid deposition. Where appropriate, pertinent environmental legislation is described, engineering models are derived and applied, and treatment technologies introduced. *Prerequisites:* CHEM 1303 and MATH 1338.

2310 (ME 2310). Statics. Equilibrium of force systems, computations of reactions and internal forces, determinations of centroids and moments of inertia, and introduction to vector mechanics. *Prerequisite:* MATH 1337 or equivalent.

2320 (ME 2320). Dynamics. Introduction to kinematics and dynamics of particles and rigid bodies. Newton's laws, kinetic and potential energy, linear and angular momentum, work, impulse, and inertia properties. *Prerequisite:* CEE 2310 or equivalent.

2331 (ME 2331). Thermodynamics. The first and second laws of thermodynamics and thermodynamic properties of ideal gases, pure substances and gaseous mixtures are applied to power production and refrigeration cycles. *Prerequisites:* CHEM 1303, CEE 2310, MATH 2339.

2340 (ME 2340). Mechanics of Deformable Bodies. Introduction to analysis of deformable bodies, including stress, strain, stress-strain relations, torsion, beam bending and shearing stresses, stress transformations, beam deflections, statically indeterminate problems, energy methods, and column buckling. *Prerequisite:* CEE 2310.

2342 (ME 2342). Fluid Mechanics. Fluid statics, fluid motion, systems and control volumes, basic laws, irrotational flow, similitude and dimensional analysis, incompressible viscous flow, boundary layer theory, and an introduction to compressible flow. *Prerequisites:* CEE 2310, MATH 2339, PHYS 1303. *Corequisite or prerequisite:* MATH 2343.

2421. Aquatic Chemistry. Aspects of chemistry that are particularly valuable to the practice of environmental engineering are examined. A basic groundwork is provided for the quantitative analysis of water and wastewater systems. Fundamental methods of instrumental analysis are examined. Elements of thermodynamics, acid-base, redox and colloidal chemistry are presented as appropriate. Laboratory sessions emphasize design, hands-on conduct of experimental procedures, and interpretation and statistical analysis of derived data. *Prerequisites:* CHEM 1303 and CHEM 1304.

3302. Engineering Communications. Both oral and written communications skills for engineers: engineering documents, writing standards and presentations; audience analysis; graphics; collaborative skills; and ethical issues. Students prepare several documents and presentations common in engineering practice. *Prerequisite:* Junior or senior standing in engineering.

3323. Water Resources Engineering. The hydrologic cycle and associated atmospheric processes are introduced through derivation and practical application of the hydrologic budget equation encompassing precipitation, evaporation, transpiration, groundwater flow and surface water runoff. Unit hydrographs and flood hydrograph routing are examined through application of hydrologic simulation models. Students are exposed to probabilistic analysis and extreme value theory for determination of flood and drought hazard. Interpretation and statistical analysis of climatologic, hydrologic and other environmental data are emphasized. Concepts of professional engineering practice are introduced with emphasis on the need for professional licensing and on project management through all phases of a typical project, including conception, planning, preparation of design drawings and specifications for bidding and procurement purposes, the interaction of design and construction professionals, and water resource systems operation. *Prerequisite:* CEE 2304. *Corequisite or prerequisite:* CEE 2342.

3325. Groundwater Hydrology. The hydrologic cycle and the subjects of porosity and permeability are introduced. Flow theory and its applications, storage properties, the Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, regional vertical circulation, unsaturated flow, and recharge are examined. Well hydraulics, stream-aquifer interaction, and distributed- and lumped-parameter numerical models are considered, as are groundwater quality, mixing cell models, contaminant transport processes, dispersion, decay and adsorption, and pollution sources. *Prerequisites:* CEE 2342 and MATH 2343.

3327. Principles of Surface Water Hydrology and Water Quality Modeling. The theory and applications of the physical processes of the hydrologic cycle are examined. Different types of water bodies – streams, rivers, estuaries, bays, harbors and lakes – are reviewed. The principal quality problems associated with bacteria, pathogens, viruses, dissolved oxygen and eutrophication, toxic substances, and temperature are examined in detail. Theoretical model approaches are emphasized. *Prerequisites:* CEE 2421 and MATH 2343.

3341. Introduction to Solid and Hazardous Waste Management. Solid and hazardous waste are defined. Technology, health and policy issues associated with solid waste and hazardous materials are examined. Methods of managing solid and hazardous waste are introduced and regulations presented where appropriate. The characteristics of hazardous and solid waste materials, health frameworks, and the distribution of contaminants in the environment are reviewed. *Prerequisites:* CEE 2304 and CEE 2421.

3350 (ME 3350). Structural Analysis. Emphasis on the classical methods of analysis of statically determinate and indeterminate structural systems. Computation of reactions, shears, moments, and deflections of beams, trusses and frames. Use of computers as an analytical tool. *Prerequisites:* CEE 2340/CEE 2140.

3353. Introduction to Environmental Toxicology. The physiological and biochemical effects of physical, chemical and biological processes are linked to factors present in the environment. Natural phenomena are described in terms of the carbon, oxygen, sulfur, phosphorus and heavy metal cycles. The processes by which anthropogenic chemicals enter the environment and their complex effects on living organisms are examined in detail. *Prerequisite:* BIOL 1402. *Corequisite or prerequisite:* CEE 5317 or equivalent.

3355. Environmental Impact Evaluation, Policy and Regulation. Methods for evaluating engineering projects on environmental quality are reviewed, as are environmental legislation and environmental quality indices. The strengths and weaknesses of government methodologies to protect the environment are reviewed. Pollution standards, marketable rights, taxes and citizen empowerment are considered. Economic analysis and other policy perspectives are considered. *Prerequisite:* CEE 2304.

3431. Fundamentals of Air Quality I. The science, engineering, public health and economic aspects of air quality are covered. Topics include the sources of air pollutants, transport of pollutants in the environment and atmospheric chemistry. The important properties and behavior of airborne particles and gases are reviewed. Also discussed are the science and national and international policies relating to greenhouse gas emissions, global climate change and stratospheric ozone depletion. *Prerequisites:* CHEM 1303, MATH 1337 or equivalent, and PHYS 1303 or equivalent.

3451. Principles of Industrial Hygiene and Occupational Health. The recognition, evaluation and control of health hazards in the working environment are presented. Principles of industrial toxicology, risk assessment/management, occupational diseases and occupational health standards are examined. The application of industrial hygiene principles and practice as well as the measurement and control of atmospheric contaminants are presented. The design and evaluation of occupational exposure controls are introduced. Lecture and three hours of laboratory. *Prerequisite:* CHEM 1304.

4329. Design of Water and Wastewater Systems. Physical, chemical and biological concepts and processes that are specific to public water supplies and municipal wastewater management are covered. Fluid mechanics is reviewed, followed by an introduction to hydraulic modeling for design of water distribution networks and wastewater collection networks. Design and operation of treatment systems for both drinking water and municipal wastewater pollution control are covered. Process modeling is employed for completion of two design projects: one for a public water supply treatment plant and the other for a municipal wastewater treatment plant. Field trips are conducted to a public water supply treatment plant and to a municipal wastewater treatment plant. *Prerequisites:* CHEM 1303, and CEE 2304 and CEE 2342.

4333. Fundamentals of Air Quality II. Fundamental and advanced topics in air quality are covered, building upon CEE 3431. Atmospheric dispersion of pollutants is examined, and modern computer models are used to predict transport. A thorough review of energy technology and energy policy is presented, focusing on the economics and environmental impacts of conventional and alternative methods of energy generation. The importance of indoor air quality is discussed, including the risks from radon and biological aerosols. Additional topics of current interest are presented. Each student prepares a term paper related to energy policy and the environment. *Prerequisites:* CEE 2331 or equivalent, and CEE 3431.

4350 (ME 4350). Design of Steel Structures. Study of strength, behavior and design of metal structures; and flexural and axial members, bolted and welded connections, and composite beams. *Prerequisite:* CEE 3350.

4351. Design of Concrete Structures. Study of strength, behavior and design of reinforced concrete structures and members subjected to flexure. Shear and axial loads. Design of one-way slabs. *Prerequisite:* CEE 3350.

4380. Civil and Environmental Engineering Design I. Students are responsible for completing a term-long environmental or civil engineering project for an industrial or regulatory client. The nature of design problems, constraints and analytical tools are examined in an applied setting. An integrated design process is employed, including problem identification and formulation, project planning, evaluation of alternatives, internal peer review and design iterations, preparation of design drawings and specifications for bidding and procurement purposes, the interaction of design and construction professionals, and implementation of the completed project. *Prerequisites:* Senior standing and CEE 3302.

4381. Civil and Environmental Engineering Design II. Students are responsible for completing a term-long environmental or civil engineering project for an industrial or regulatory client. Students function on multidisciplinary design teams that stress the need for personal and written communication skills, leadership, effective group participation and creative problem solving. Concepts of professional engineering practice are reinforced by student participation in applied design problems, including the need for professional licensing; the ethical responsibilities of licensed engineers; and the need for lifelong learning to stay abreast of changing technology and public policy through active participation in professional societies, self-study and continuing education. Periodic progress reports and reviews and a final report are prepared and presented. Both the client and faculty assess the completed design project. *Prerequisite:* CEE 4380.

4385. Soil Mechanics and Foundations. Introduction to the basic principles that govern the behavior of soils, foundations and other geotechnical engineering works. The central concepts covered include the index properties and classification of soils, soil permeability and pore water movement, stress distribution in soil and the effective stress concept, bearing capacity, compressibility, consolidation, settlement, shear strength, and soil engineering properties and their measurement. Geotechnical facilities introduced include foundations, retaining walls, tunnels, excavations, earth fill dams, pavements, stable earth slopes, sanitary landfills and environmental remediation projects. *Prerequisite:* CEE 2340.

5050. Undergraduate Internship.

5090. 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 civil and environmental engineering. All students, staff and faculty are invited.

5311. Environmental and Hazardous Waste Law. 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 EPA; compliance and enforcement; and case studies.

5312. Risk Assessment and Health Effects. Introduction to toxicology as it relates to environmental and health effects of hazardous materials; toxicological methodology; risk management factors, including legal aspects; human health and ecological risk assessment and risk communication; emergency response; and computer databases.

5313. Environmental Chemistry and Biology. Chemical and biochemical processes; controlling fate and transport of hazardous materials, with emphasis on chemical equilibria; chemical thermodynamics; acid-base equilibria; precipitation and dissolution; oxidation-reduction processes; environmental transformations of organic materials; introductory taxonomy; microbial growth and kinetics; energy transfer; and microbial ecosystems.

5314. 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 and hazardous waste. Air, water, storm water and waste permits are reviewed, as well as permits-by-rule. Also explored are the consequences of noncompliance with regulations by presenting enforcement options available to government agencies.

5315. 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.

5317. Environmental Organic Chemistry. This course will examine the fundamental processes that govern transformations of organic chemicals in natural and engineering systems. The course will be divided into three parts: 1) organic chemistry overview, 2) physical transformations of organic compounds and 3) organic chemical reactions in the environment. The organic chemistry overview will provide knowledge regarding basic properties of organic compounds, such as nomenclature and structures. Physical transformation of organic compounds will provide an understanding of processes (such as sorption and volatilization) that control the distribution of organic chemicals between different phases (such as air, water and soil). Environmentally mediated reactions (such as hydrolysis and photolysis) that control the breakdown of organic chemicals will be the focus of chemical reactions.

5321. Physical and Chemical Waste Treatment. Waste minimization techniques and objectives are introduced. Chemical equilibrium and chemical reaction kinetics are thoroughly reviewed. Design and analysis equations and procedures are rigorously derived for chemical reactors and physical unit operations. The treatment objectives examined include 1) solids-liquid separation accomplished by coagulation and flocculation, sedimentation, filtration, flotation, and solids handling processes; 2) immiscible liquid separation brought about by emulsion-breaking chemicals and gravity and flotation oil/water separators; 3) phase and species transformations through pH neutralization, chemical precipitation, chemical oxidation/reduction, air stripping and solidification/stabilization; and 4) solute separation and concentration achieved with activated carbon absorption, synthetic ion exchange resins and membrane separation techniques.

5322. Biological Waste Treatment. Biological treatment topics include an overview of microbiology and microbial metabolism; kinetics of biological growth; aerobic suspended growth processes, including the various modifications of the activated sludge process, aerated lagoons and sequencing batch reactors; aerobic attached growth processes, including trickling filters, biofilter towers and rotating biological contactors; anaerobic processes, including sludge digestion and liquid waste treatment with the anaerobic contact process and anaerobic filters; biosolids handling and disposal; composting; land treatment; and *in situ* biotreatment and biotreatment of contaminated soils.

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

5325. Disaster Management. This course introduces the student to basic concepts in disaster management. Drawing on a range of sources, from the textbook to the U.S. Disaster Response Plan to research papers, the course covers the fundamentals of preparedness, mitigation, response and recovery. An all-hazards approach is taken, providing analysis of natural, technological and man-made disasters. In addition to discussing basic theories of disaster management, the course introduces the student to key methods in the field, including simulation modeling, consequence analysis tools, design criteria, statistical and case study methods ("lessons learned"), and risk analysis.

5327. Optimization and Reliability for Infrastructure and Environmental Systems. This course introduces the concepts of engineering systems optimization, reliability and risk assessment, and applies them to civil and environmental engineering systems. Topics include an introduction to engineering systems definition, classical methods of optimization, linear programming, integer programming, dynamic programming, nonlinear optimization, and reliability and risk concepts in engineering planning and design. Engineering applications will include transportation networks, fleet assignment, supply chain management, environmental engineering systems, fluid transport, and water reservoir operation and structural engineering systems. Advanced topics will include an introduction to chance-constrained optimization and basic decomposition approaches and their application to real-world problems. *Prerequisite:* Graduate standing or permission of instructor.

5328. 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. Topics include air quality and energy supply, sustainable construction, water use, transit, and other related areas of resource use and waste generation. Guest lecturers will provide a series of multiple viewpoints and areas of specific expertise. *Prerequisite:* Graduate standing or permission of instructor.

5329. Methods and Technology for Sustainability. This course covers technologies and methods using 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.

5330. 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 permission of instructor.

5331. Air Pollution Management and Engineering. This course covers the science, engineering, public health and economic aspects of air quality. Students will develop an in-depth understanding and broad knowledge of the sources and properties of air pollutants, air quality management, transport of pollutants in the environment, regulations of air quality, and the operation and design of air pollution control systems. In addition, the class will review the current status of science, policy and regulations on several selected topics such as urban smog, regional haze, greenhouse gas and global climate change, stratospheric ozone depletion, and mercury emissions and control. *Prerequisites:* CHEM 1304, MATH 1337 or equivalent, and PHYS 1303 or equivalent.

5332. Groundwater Hydrology and Contamination. Groundwater hydrology; aquifer and well hydraulics; flow equations and models; implications for landfill design; sources and nature of groundwater contaminants; monitoring and analysis; contaminant fate and transport; transport model for hazardous substances; groundwater pollution control measures; containment and treatment; and groundwater quality management. *Prerequisite:* MATH 2343.

5333. Laboratory Methods in Environmental Engineering. This course provides students with hands-on, state-of-the-art experience with important experimental methods in environmental systems, evaluating the reliability and significance of parameter determinations. Covers instrumental and statistical methods used for characterization of water, air and soil quality. Introduction to treatability studies, including reactor dynamics. The course format provides two hours of lecture and three hours of laboratory component. *Prerequisite:* CEE 5313 or two terms of undergraduate chemistry.

5334. Fate and Transport of Contaminants. Development and application of fate and transport models for water-borne contaminants with focus on material balance principle; mass transport and transformation processes; modeling of lakes and reservoirs; stream modeling; general flow case; groundwater models; water-sediment, water-soil and water-air interfaces; multiphase and integrated modeling approaches; and case studies.

5335. Aerosol Mechanics. Fundamental and advanced principles of airborne particles, including their physical properties; aerodynamic behavior; and their collection, measurement and analysis. The course emphasizes the origins and properties of atmospheric aerosols and the design of air pollution equipment. *Prerequisites:* CEE 3431, and CEE 2342 or equivalent.

5340 (ME 5340). Introduction to Solid Mechanics. Three-dimensional stress and strain, failure theories, introduction to two-dimensional elasticity, torsion of prismatic members, beams on elastic foundations, introduction to plates and shells, and energy methods. *Prerequisites:* CEE 2340 and MATH 2343.

5350. Introduction to Environmental Management Systems. An in-depth introduction to environmental management systems. Includes systems such as EMAS, Responsible Care, OSHAS 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 review, and allows students to fully understand the plan-do-check-act approach of the system. Also introduces students to management system auditing, the requirements of a system auditor and the certification process.

5351. Introduction to Environmental Toxicology. Toxicology is presented as it relates to environmental and health effects of hazardous materials. Toxicological methodologies, pharmacokinetics, mechanisms of action to toxicants, origin response to toxic substances, and relevant aspects of the occupational and regulatory environment will be examined. Specific topics include toxicology of metals, radiation, industrial solvents and vapors, pesticides, teratogens, mutagens, and carcinogens. Risk communication and risk assessment are examined as they relate to toxic substance exposure.

5352. Management of Radioactive Hazards. Principles of radioactive material production, uses and hazards are presented with emphasis on safe control and management of radioactive material. 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.

5353. 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.

5354. Environmental Engineering Principles and Processes. Waste minimization and pollution prevention techniques and objectives are introduced. A comprehensive study is made of biological, chemical and physical principles and treatment strategies for controlling pollutant emissions. Equal emphasis is placed on underlying theory and practical engineering 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 of unit processes to achieve specific treatment objectives. *Prerequisites:* CHEM 1303, CEE 2304 and CEE 2342, and MATH 2343.

5361 (ME 5361). Matrix Structural Analysis and Introduction to Finite Element Methods. A systematic approach to formulation of force and displacement method of analysis, representation of structures as assemblages of elements, and computer solution of structural systems. *Prerequisite:* CEE 3350.

5362 (ME 5362). 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.

5363. Architectural and Structural Engineering. The basic principles of structural analysis and mechanics of deformable bodies are introduced. Structural systems and principles are presented with an emphasis on architectural design. Students will be provided with a conceptual introduction to structures emphasizing the integration of structural and architectural design. Case studies of buildings are presented and discussed. *Prerequisites:* CEE 2310 and CEE 2320.

5364. 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; and introduction to systems with distributed mass and flexibility. *Prerequisite:* MATH 2343.

5365. 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.

5366. Introduction to Facilities Engineering Systems. The inter-relationships 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.

5367. Telecommunications in Facility Planning. A thorough description of telecommunications technology is presented. Provides the student with a working knowledge of the fundamental concepts of telecommunications technology for voice and data. Topics presented include digital communications, standards and protocols, Ethernets, local area networks, fiber optics, and voice technologies.

5368. Facilities Contract Management. A critical foundation and understanding are 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.

5369. 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.

5370. 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.

5371. 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 valuations 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.

5372. Introduction to CAD. Provides students with hands-on, state-of-the-art experience with computer-aided drafting using AutoCAD to produce drawings used for engineering presentations and construction. Students will learn how to draw lines and curvilinear lines, use blocks and external references, write text, create plot files, and apply many other commands necessary to produce engineering drawings as used to construct environmental, civil and structural engineering projects.

5373. Prestressed Concrete. Theory and application of prestressed concrete members, time-dependent deflections and continuous prestressed beams. *Prerequisite:* CEE 4350.

5375. Advanced Concrete Design. Behavior, analysis and design of concrete slender columns, two-way slab systems and deep beams. Yield line analysis for slabs. Design and behavior of shear walls, retaining walls and foundations systems. *Prerequisite:* CEE 4350.

5377. 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.

5378. Transportation Planning and Traffic Engineering. This course is concerned mainly with the analysis and modeling of urban transportation systems. The course consists of three main parts. The first part provides an overview of main definitions and terminologies involved in the planning and modeling of urban transportation systems. The second part introduces the concept of urban transportation planning systems along with an overview of various models used in travel demand forecasting. The third part describes principles of traffic operations, analysis and control. *Prerequisite:* Basic principles of probability and statistics.

5383 (ME 5383). Heating, Ventilating and Air Conditioning. Examines the science and practice of controlling environmental conditions through the use of thermal processes and systems. Specific applications include refrigeration, psychometrics, solar radiation, heating and cooling loads in buildings, and design of duct and piping systems. Theory and analysis are emphasized. *Prerequisites:* CEE 2331, CEE 2342 and ME 3332.

5384. Energy Management for Buildings. Procedures to select energy saving options for buildings are examined with emphasis on the practical aspects of the subject. Space planning, architectural considerations, cost and environmental impact of the mechanical and electrical systems are considered along with optimizing the life-cycle cost of the proposed alternative. Software for life-cycle cost and energy analysis is used to calculate energy consumption and compare energy features of proposed, audit-determined feasible changes to a building.

5385. 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.

5386. 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.

5387. 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. *Prerequisite:* CEE 5364 or approval of instructor.

5388. 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. *Prerequisite:* CEE 4385 or equivalent.

5418. 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. *Prerequisites:* CHEM 1303, CHEM 1304, or equivalent.

5(1–4)9(1–2). Special Projects. Intensive study of a particular subject or design project, not available in regular course offerings, under the supervision of a faculty member approved by the department chair.

COMPUTER SCIENCE AND ENGINEERING

Professor Sukumaran Nair, **Chair**

Professors: Margaret Dunham, David Matula, Sukumaran Nair, Stephen Szygenda, Mitchell Thornton, Jeff Tian. **Associate Professors:** James Dunham, Richard Helgason. **Assistant Professors:** LiGuo Huang, Yuhang Wang. **Visiting Assistant Professor:** Michael Hahsler. **Senior Lecturer:** Frank Coyle. **Lecturers:** Donald Evans, Mark Fontenot. **Adjunct Faculty:** Jeffrey Alcantara, Abdelhalim Alsharqawi, William Bralick, Ann Broihier, Hakki Çankaya, Ebru Celikel, Christian Christensen, Aaron Estes, Jahanzeb Faizan, Dennis Frailey, Prasad Golla, Khalid Ishaq, Bhanu Kapoor, Mohamed Khalil, Kamran Khan, Lacy Lapio, Karl Lewis, Lun Li, Kall Loper, Babu Mani, Matt McBride; Lee McFearin, Freeman Moore, Padmaraj M.V. Nair, Robert Oshana, John Pfister, Leonid Popokh, Mohamed Rayes, T. Brett Spell, Gheorghe Spiride, Stephen Stepoway, Raymond Van Dyke.

The Department of Computer Science and Engineering at SMU offers academic programs in computer engineering and computer science. Faculty specializations include computer architecture, knowledge engineering, software engineering, design and analysis of algorithms, parallel processing, database management, very large-scale integration computer-aided design methods, bioinformatics, computer networks, data and network security, mobile computing, theory of computation, and computer arithmetic. The educational objectives of the undergraduate programs in the CSE Department are to produce graduates who are productive professionals in an information technology discipline, are pursuing (or have pursued) graduate or professional degrees, are successful entrepreneurs and managers, have a broad knowledge and wide range of interests, are valuable members of their general community, and take a leadership role in their chosen field. As such, the programs are designed to ensure that graduates have:

For graduates with degrees in computer science:

a) An ability to apply knowledge of computing and mathematics to software design and computing problems.
b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.
c) An ability to design, implement and evaluate a computer-based system, process, component or program to meet desired needs.
d) An ability to function effectively on teams to accomplish a common goal.
e) An understanding of professional, ethical, legal, security and social issues and responsibilities.
f) An ability to communicate effectively with a range of audiences both in an oral and written form.
g) The broad liberal arts education necessary to analyze the local and global impact of computing on individuals, organizations and society.
h) Recognition of the need for, and an ability to engage in, continuing professional development and lifelong learning.
i) An ability to use the techniques, skills and modern computing and software engineering tools necessary for computing practice.

For graduates with degrees in computer engineering:

a) An ability to apply knowledge of mathematics, science and engineering to software and hardware design problems.
b) An ability to design and conduct experiments and to analyze and interpret data related to software and hardware design solutions.
c) An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

d) An ability to function on multidisciplinary teams using current computer engineering tools and technologies.
e) An ability to identify, formulate and solve engineering problems based on a fundamental understanding of concepts of computer engineering topics.
f) An understanding of personal, professional and ethical responsibility.
g) An ability to communicate effectively both in an oral and written form.
h) The broad liberal arts education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.
i) Recognition of the need for, and an ability to engage, in lifelong learning.
j) Knowledge of contemporary issues in computer engineering.
k) An ability to use the techniques, skills and modern engineering tools necessary for computer engineering practice.

The CSE Department is engaged in an ongoing assessment process that evaluates the success in meeting these outcomes and enhances the development of the program.

Degrees

Bachelor of Science – Major in Computer Science (123/124* term credit hours)
Bachelor of Science – Major in Computer Science With a Premedical Specialization (129 term credit hours)
Bachelor of Science in Computer Engineering (127 term credit hours)
Bachelor of Arts – Major in Computer Science (122 term credit hours)

** The B.S. in computer science degree in the gaming track requires one additional hour of coursework.*

The undergraduate program in computer engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700. The undergraduate computer science program that awards the degree Bachelor of Science (B.S.) is accredited by the Computing Accreditation Commission of ABET. The undergraduate computer science program that awards the degree Bachelor of Arts (B.A.) is not accredited by a Commission of ABET.

Dual Degree Program

The Lyle School of Engineering offers a dual degree with the Meadows School of the Arts that leads to the degrees of B.A. in music and B.A. in computer science. Contact the department for additional details.

4+1 Master's Degree Program

The 4+1 Program allows students to complete both B.S. and M.S. degrees in five years. In the CSE Department, students may participate in the 4+1 Program in either the computer science or computer engineering area. Up to nine total credit hours of graduate courses may be applied toward fulfilling the student's undergraduate program requirements. For additional information, contact the undergraduate program director.

Teaching Certification

The teacher certification program requires 24 hours of coursework and six hours of student teaching. Thus a B.A. in computer science student is able to complete these requirements by taking all required education courses within the free electives area. In addition, the student would have to complete student teaching. For information on this program, contact the CSE Department.

Computer Facilities

Students in the CSE Department have access to a wide range of facilities and equipment. The department's computing environment has evolved into an Ethernet-based network of personal computers and servers. General-use UNIX servers that run OSF1 and Linux are available. A wireless network is also available throughout the CSE facilities. Windows-based PC labs are used during the first two years of coursework. Access to the network is also available via open-area labs containing PCs.

Curriculum in Computer Science

Computers play an ever-increasing role in our society. Their use permeates all other academic disciplines and industrial arenas. Computer science is the study of the concepts and theory surrounding computer design and software construction. The SMU undergraduate program in computer science is designed to give students a solid understanding of these concepts, providing them with the technical knowledge needed to pursue either an advanced degree or a challenging career in the computer industry. The diversity of the Lyle School of Engineering computer environment exposes undergraduate computer science students to many different hardware and software systems.

To study and use computers, one must communicate with them through a variety of software interfaces, including programming languages. At SMU, the student will study several high-level languages – such as C++ and Java – that simplify the use of computers. In addition, students are exposed to a variety of computer-aided software engineering tools and expert systems shells. Assembly languages and operating systems (such as UNIX) for micro-, mini- and mainframe computers are studied to provide an understanding of the architecture and organization of a digital computer. Mathematical topics such as discrete mathematics, graph theory, and Boolean and linear algebra are included in required undergraduate classes so that students may better understand the internal structure of the computer and the effective utilization of its languages.

Knowledge of the computer's internal structure is important to understanding its capabilities. Thus, computer science students take courses in assembly language, computer logic and computer organization. Courses in systems programming and operating systems extend this structural study into the "software" of the computer. A required sequence of software engineering courses prepares students for advanced systems and software applications.

The free electives in the B.A. in computer science program can also be used to individually tailor a student's study plan. For example, students who want a program even more intensive than the computer science major could satisfy their free electives with more computer science courses. Students interested in a broader education could satisfy these electives with courses offered by any department in the University.

The B.S. degree allows students to major in any of three concentration tracks or to pursue a general program where they can choose nine hours of computer science electives. The research track allows students to participate in an undergraduate research project of their choice. Like graduate students, undergraduate students majoring in research are required to perform independent research in an area of their choice (with a tenure-track faculty member as an adviser), document the research results and present the results of the research in a presentation open to the entire University community. The security track facilitates a more in-depth study of software security issues. The game development track is provided in collaboration with The Guildhall at SMU.

Bachelor of Science With a Major in Computer Science

Curriculum Requirements:

Area	*Required Courses*	*Term Credit Hours*
Liberal Studies:	ENGL 1301, 1302	6
	Perspectives	9–12
	Cultural Formations	3–6
	(One Perspectives course *or* one Cultural Formations course must satisfy the human diversity requirement.)	
Mathematics:	MATH 1337, 1338, 3353	9
	CSE 2353, 3365, 4340	9
	(Students may fulfill the CSE 4340 requirement by taking any one of CSE/STAT/EMIS 4340, EMIS 5370 or STAT 5340.)	
Science:	PHYS 1105, 1106, 1303, 1304	8
	Six term credit hours from the following:	6
	ANTH 2315, 2363	
	BIOL 1401, 1402	
	CHEM 1113, 1114, 1303, 1304	
	GEOL 1301, 1305, 1307, 1308, 1313	
	PHYS 3305	
Computer Science:	CSE 1341, 1342, 2240, 2341, 3330, 3342, 3345, 3353, 3381, 4344, 4345, 4381, 5343	38
Tracks and Electives:		12/16*
Research:	CSE 4346, 4397, 5350	
	Any additional 3-hour CSE course numbered 5000 or above and 3 hours of research track electives as approved by adviser	
Game Development:	CSE 4051; HGAM 5201, 5202, 5221, 5222, 5270, 5311, 5312	
	(These courses must be taken at The Guildhall at SMU, and all students in this track must be admitted to the Guildhall Professional Certificate program.)	
Security:	CSE 4346, 5339, 5349	
	Any additional 3-hour CSE course numbered 5000 or above and 3 hours of security track electives as approved by adviser	
General:	CSE 4346 and any three 3-hour CSE courses numbered 5000 or above and 3 hours of general electives as approved by adviser	
Electives:	Advanced electives in the Lyle School of Engineering	9/6*
Engineering Leadership:	CEE 3302, CSE 4360, EMIS 3308	9
Wellness:		2
	Total	**123/124***

* *Students choosing the gaming track require 16 hours of coursework in the game development track and only 6 hours of advanced electives in the Lyle School of Enginering for a total degree requirement of 124 hours.*

Bachelor of Science With a Major in Computer Science
Bioinformatics Track

Curriculum Requirements:

Area	*Required Courses*	*Term Credit Hours*
Liberal Studies:	ENGL 1301, 1302	6
	Perspectives	9–12
	Cultural Formations	3–6
	(One Perspectives course *or* one Cultural Formations course must satisfy the human diversity requirement.)	
Mathematics:	MATH 1337, 1338, 3353	9
	CSE 2353, 3365, 4340	9
	(Students may fulfill the CSE 4340 requirement by taking any one of CSE/STAT/EMIS 4340, EMIS 5370 or STAT 5340.)	
Science:	BIOL 1401, 3304	7
	CHEM 1113, 1303	4
	PHYS 1105, 1106, 1303, 1304	8
Computer Science:	CSE 1341, 1342, 2240, 2341, 3330, 3342, 3345, 3353, 3381, 4344, 4345, 4346, 4381, 5343	41
Bioinformatics Track:	BIOL 5305	3
	CSE 5331, 5335	6
	Any one additional 3-hour CSE course numbered 5000 or above as approved by adviser	3
Engineering Leadership:	CEE 3302, CSE 4360, EMIS 3308	9
Wellness:		2
	Total	**122**

Bachelor of Science With a Major in Computer Science
With Premedical Specialization

Curriculum Requirements:

Area	*Required Courses*	*Term Credit Hours*
Liberal Studies:	ENGL 1301, 1302	6
	Perspectives	9–12
	Cultural Formations	3–6
	(One Perspectives course *or* one Cultural Formations course must satisfy the human diversity requirement.)	
Mathematics:	MATH 1337, 1338, 3353	9
	CSE 2353, 3365, 4340	9
	(Students may fulfill the CSE 4340 requirement by taking any one of CSE/STAT/EMIS 4340, EMIS 5370 or STAT 5340.)	
Science:	BIOL 1401, 1402, 3304, 3350	14
	CHEM 1113, 1114, 1303, 1304, 3117, 3118, 3371, 3372	16
	PHYS 1105, 1106, 1303, 1304	8
Computer Science:	CSE 1341, 1342, 2240, 2341, 3330, 3381, 3342, 3345, 3353, 4344, 4345, 4346, 4381, 5343	41
	Three term credit hours from the following:	3
	CSE 5314, 5320, 5330, 5339, 5341, 5342, 5344, 5345, 5348, 5349, 5350, 5359, 5376, 5380, 5381, 5382, 5385, 5387	
Engineering Leadership:	CEE 3302, CSE 4360	6
Wellness:		2
	Total	**129**

Bachelor of Arts With a Major in Computer Science

Curriculum Requirements:

Area	*Required Courses*	*Term Credit Hours*
Liberal Studies:	ENGL 1301, 1302	6
	Perspectives	15
	Cultural Formations	6
	(One Perspectives course *or* one Cultural Formations course must satisfy the human diversity requirement.)	
Mathematics:	MATH 1337, 1338	6
	CSE 2353	3
Science:	PHYS 1313	3
	STAT 2331	3
	Three term credit hours from the following:	3
	ANTH 2315, 2363	
	BIOL 1303, 1304, 1308, 1401, 1402	
	CHEM 1301, 1303, 1304	
	GEOL 1301, 1305, 1307, 1308, 1313	
	PHYS 1303, 1304, 1314, 3305	
Computer Science:	CSE 1341, 1342, 2240, 2341, 3330, 3342, 3345, 3353, 3381, 4344, 4345, 4346, 4381, 5343	41
	Six term credit hours from the following:	6
	CSE 5314, 5320, 5330, 5339, 5341, 5342, 5344, 5345, 5348, 5349, 5350, 5359, 5376, 5380, 5381, 5382, 5385, 5387	
Engineering Leadership:	CEE 3302, CSE 4360, EMIS 3308	9
Free Electives:	The free electives must be approved by the adviser.	19
Wellness:		2
	Total	**122**

Minor in Computer Science

A student majoring in computer engineering may not minor in computer science.

Requirements:

CSE 1341 Principles of Computer Science I
CSE 1342 Programming Concepts
CSE 2341 Principles of Computer Science II
CSE 2353 Discrete Computational Structures

Elective Courses:

Any six hours of CSE courses numbered 3000 or above as approved by the computer science minor adviser.

Curriculum in Computer Engineering

Computer engineering deals with computers and computing systems. Computer engineers must be capable of addressing problems in hardware, software and algorithms, especially those problems whose solutions depend upon the interaction of these elements.

Career opportunities for computer engineers require a broad range of knowledge. The design and analysis of logical and arithmetic processes that are the basis of computer science provide basic knowledge. Computer engineering courses are concentrated on the interacting nature of hardware and software. Basic electrical engineering is a clear foundation for computer engineers.

Bachelor of Science With a Major in Computer Engineering

Curriculum Requirements:

Area	*Required Courses*	*Term Credit Hours*
Liberal Studies:	ENGL 1301, 1302	6
	Perspectives	9–12
	Cultural Formations	3–6
	(One Perspectives course *or* one Cultural Formations course must satisfy the human diversity requirement.)	
Mathematics:	MATH 1337, 1338, 2343, 3353	12
	CSE 2353, 3365, 4340	9
	(Students may fulfill the CSE 4340 requirement by taking any one of CSE/STAT/EMIS 4340, EMIS 5370 or STAT 5340.)	
Science:	CHEM 1303	3
	PHYS 1106, 1303, 1304	7
	Three term credit hours from the following:	3
	BIOL 1401, 1402	
	CHEM 1304	
	GEOL 1301	
	PHYS 3305	
Engineering Leadership:	CEE 3302, CSE 4360, EMIS 3308	9
Computer Engineering:	CSE 1341, 1342, 2240, 2341, 3353, 3381, 4344, 4381, 5343, 5387	29
	EE 2122, 2170, 2322, 2350, 2370	11
Tracks:		12
Hardware:	CSE 4386	
	Three of the following:	
	CSE 5380, 5381; CSE 5385 or EE 5385; CSE 5356 or EE 5356	
Software Engineering:	CSE 3345, 4345, 4346, 5314 or 5316 or 5319	
Networking:	CSE 4347	
	Three of the following:	
	CSE 5344, 5348, 5349; EE 5376	
Wellness:		2
Electives:	Advanced electives in the Lyle School of Engineering	9
	Total	**127**

Minor in Computer Engineering

A student majoring in computer science may not minor in computer engineering.

Requirements:

CSE 1341 Principles of Computer Science I
CSE 1342 Programming Concepts
CSE 2240 Assembly Language Programming and Machine Organization
CSE 2341 Principles of Computer Science II
CSE 2353 Discrete Computational Structures
CSE 3381 Digital Logic Design

The Courses (CSE)

1319. Introduction to Digital Imaging. Presents an overview of digital imaging in its many varied aspects from the simple to the complex. The hardware reviewed is photographic, video and scanned conversion mechanisms, and software for editing and converting photographic and video images is introduced. The science behind the electronic image is discussed in detail. This course resolves the many mystifying technical issues involved in the creation, manipulation, processing and output of digital images through myriad examples, detailed technical information and practical laboratory assignments. *Prerequisite:* Familiarity with computers. Some programming experience helpful but not required.

1331. Introduction to Web Programming. Examines technologies and techniques for building three-tier Web-based applications. Topics include technologies for developing client-tier graphical user interfaces, server-tier technologies for processing client requests, and data-tier database technologies for managing and storing both relational and XML data. Issues related to Web security will be studied throughout the course. All students will participate in team-based collaborative projects.

1340. Introduction to Computing Concepts. Introduction to computer concepts, program structures, object-oriented programming and interactive application development. Extensive programming projects emphasizing logical control structures and the use of libraries.

1341. Principles Of Computer Science. Introduction to the fundamental concepts of computer science and object-oriented design of reusable modules. The course covers basic object-oriented concepts of composition, inheritance, polymorphism and containers. First course for computer science and computer engineering majors and minors.

1342. Programming Concepts. Introduction to the constructs provided in the C/C++ programming language for procedural and object-oriented programming. Computation, input and output, flow of control, functions, arrays and pointers, linked structures, use of dynamic storage, and implementation of abstract data types. *Prerequisites: C-* or better in CSE 1341 or equivalent, a grade of at least a 4 on the AP Computer Science A Exam or departmental consent.

2240. Assembly Language Programming and Machine Organization. Computer-related number systems, machine arithmetic, computer instruction set, low-level programming, addressing modes and internal data representation. *Corequisite: C-* or better in CSE 1341.

2337. Introduction to Data Management. This course is designed to provide practical experience using a relational database system and spreadsheet system. The course emphasizes hands-on practical training in the creation and access of relational databases as well as basic and intermediate data analysis using spreadsheet software. Integrating data from a spreadsheet and relational database into other document types is also covered. No credit for computer science or computer engineering majors or minors. *Prerequisite:* EMIS 1305 or ME 1305. *Prerequisite/corequisite:* SOCI 2377.

2341. Data Structures. Emphasizes the object-oriented implementation of data structures, including linked lists, stacks, queues, sets and binary trees. The course covers object-oriented software engineering strategies and approaches to programming. *Prerequisite: C-* or better in CSE 1342 or equivalent.

2353. Discrete Computational Structures. Logic, proofs, partially ordered sets and algebraic structures. Introduction to graph theory and combinatorics. Applications of these structures to various areas of computer science. *Prerequisite: C-* or better in CSE 1341.

3330. Database Concepts. This course provides coverage of fundamental information management and database systems concepts, including file and disk organization, information models and systems, data modeling, relational database design, physical implementation of database systems, and query languages for accessing databases systems. As time permits, topics from information privacy and security, information storage and retrieval, data mining, and multimedia information systems will be included. *Prerequisites: C-* or better in CSE 2341 and 2353.

3342. Programming Languages. Introduction to basic concepts of programming languages and compilers, including formal syntax, regular languages and finite automata, lexical analysis, context-free grammar and parsing, static and dynamic scoping, equivalence and consistency of data types, control constructs, encapsulation and abstract data types, storage allocation, and run-time environment. Advanced programming techniques such as tail recursion, inheritance, polymorphism, static and dynamic binding, and exception handling. In-depth studies of representative languages of different programming paradigms – object-oriented, logic and functional programming. *Prerequisite: C-* or better in CSE 2341.

3345. Graphical User Interface Design and Implementation. Introduction to the concepts underlying the design and implementation of graphical use interfaces with emphasis on the psychological aspects of human-computer interaction. The course is structured around lectures, case studies and student projects. This course will introduce event-driven programming concepts, including the Java API, applications, applets, interfaces, graphics, basic and advanced GUI components, HTML, and multithreading. *Prerequisite: C-* or better in CSE 2341 or equivalent.

3353. Fundamentals of Algorithms. Introduction to algorithm analysis, big-Oh notation and algorithm classification by efficiency. Basic algorithm design strategies and approaches to problem solving. Sorting and searching algorithms. Introduction to graph theory and graph algorithms. *Prerequisites: C-* or better in CSE 2341 and 2353.

3365 (MATH 3315). Introduction to Scientific Computing. An elementary survey course that includes techniques for root-finding, interpolation, functional approximation, linear equations and numerical integration. Special attention is given to MATLAB programming, algorithm implementations and library codes. *Prerequisite: C-* or better in MATH 1338. *Corequisites:* CSE 1340 or 1341; students registering for this course must also register for an associated computer laboratory.

3381. Digital Logic Design. Boolean functions, logic gates, memory elements, synchronous and asynchronous circuits, shift registers and computers, and logic and control. *Prerequisites: C-* or better in CSE 2240 and 2353. *Corequisite:* Weekly no-credit lab.

4051. Gaming Design Project. This course requires students enrolled in HGAM 5391 to produce appropriate reports and other design documentation material resulting from their HGAM 5391 design experience. Design requirements, specifications, test plans and other relevant documentation as required for assessing the design experience are included in these materials. *Corequisite:* HGAM 5391.

4340 (STAT 4340). Statistical Methods for Engineers and Applied Scientists. Basic concepts of probability and statistics useful in the solution of engineering and applied science problems. Topics: probability, probability distributions, data analysis, sampling distributions, estimation and simple tests of hypothesis. *Prerequisites:* MATH 1337 and 1338.

4344. Computer Networks and Distributed Systems. Introduction to network protocols, layered communication architecture, wired and wireless data transmission, data link protocols, network routing, TCP/IP and UDP, e-mail and the World Wide Web, introduction to distributed computing, mutual exclusion, linearizability, locks, and multithreaded computing. *Prerequisite: C-* or better in CSE 2341.

4345. Software Engineering Principles. Introduction to software system development. Overview of development models and their stages. System feasibility and requirements engineering, architecture and design, validation and verification, maintenance and evolution. Project management. Review of current software engineering literature. Student teams will design and implement small-scale software systems. Class presentations. The course contains a major design experience. *Prerequisites: C-* or better in CSE 2341 and senior standing.

4346. Software Engineering Design Project. Project course, with a major design component. Students participate in a multidisciplinary group project team. There will be topical discussions in relation to the project, which include software development life cycle, project team organization, project planning and scheduling, management, testing and validation methods, industrial standards and interfaces, and the importance of lifelong learning. The group project will provide the major design experience for students in the computer science program and the software engineering track of the computer engineering program. *Prerequisite: C-* or better in CSE 4345.

4347. Networks Design Project. Project course, with a major design component. Students participate in a multidisciplinary group project team. There will be topical discussions in relation to the project, which include network protocols, layered communication architecture, data communication, data link protocols, internetworking, routing, congestion control, industrial standards and interfaces, and the importance of lifelong learning. The group project will provide the major design experience for students in the networks track of the computer engineering program. *Prerequisite: C-* or better in CSE 4344.

4360. Technical Entrepreneurship. Demonstrates the concepts involved in the management and evolution of rapidly growing technical endeavors. Students are expected to participate in active learning by doing, making mistakes and developing solutions, and observing mistakes and approaches made by the other teams. *Prerequisite:* Junior standing or higher.

4381. Digital Computer Design. Machine organization, instruction set architecture design, memory design and control design: hardwired control and microprogrammed control, algorithms for computer arithmetic, microprocessors and pipelining. *Prerequisite: C-* or better in CSE 3381.

4386. Hardware Design Project. Project course, with a major design component. Students participate in a multidisciplinary group project team. There will be topical discussions in relation to the project, which include the hardware design and manufacturing process, hardware description languages, modular design principles, quantitative analysis, industrial standards and interfaces, and the importance of lifelong learning. The group project will provide the major design experience for students in the hardware track of the computer engineering program. *Prerequisite: C-* or better in CSE 4381.

4(1–4)9(0–4). Undergraduate Project. An opportunity for the advanced undergraduate student to undertake independent investigation, design or development. Variable credit from one to four term hours. Written permission of the supervising faculty member is required before registration.

4(1–3)97. Research Experience for Undergraduates. This course provides research experience for junior/senior undergraduate students. Variable credit from one to three hours is given for this course. Permission from the advising CSE faculty member is required before registration. *Prerequisites:* Junior/senior standing; computer science or computer engineering major with GPA over 3.0.

5050. Undergraduate Internship.

5111. Intellectual Property and Information Technology. This course 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.

5311. Fundamentals of Computer Science. A comprehensive foundation course covering the major aspects of computer science. The course will cover hardware and software fundamentals, operating systems concepts, data structures, discrete structures, algorithms and programming languages. The course will also address issues related to software engineering and object-oriented programming. This course is intended to prepare students without a computer science background for the SMU Master's program in software engineering.

5314. 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. *Prerequisites: C-* or better in all previous CSE courses and senior standing. It is strongly recommended that students have software engineering experience in industry.

5316. Software Requirements. 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. nonfunctional requirements and the relationship of requirements to software testing. *Prerequisites: C-* or better in all previous CSE courses and senior standing.

5319. Software Architecture and Design. Software development requires 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 tradeoffs 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. *Prerequisites: C-* or better in all previous CSE courses and senior standing.

5320. Artificial Intelligence. Introduction to basic principles and current research topics in artificial intelligence. Formal representation of real-world problems; search of problem spaces for solutions; and deduction of knowledge in terms of predicate logic, nonmonotonic reasoning and fuzzy sets. Application of these methods to important areas of artificial intelligence, including expert systems, planning, language understanding, machine learning, neural networks, computer vision and robotics. *Prerequisites: C-* or better in CSE 3342 and 3353.

5330. File Organization and Database Management. A survey of current database approaches and systems, principles of design, and use of these systems. Query language design and implementation constraints. Applications of large databases. Includes a survey of file structures and access techniques. Use of a relational DBMSto implement a database design project. *Prerequisite: C-* or better in CSE 3330.

5331. An Introduction to Data Mining and Related Topics. The purpose of this course is to introduce students to various data mining and related concepts. All material covered will be reinforced through hands-on implementation exercises. In this introductory course, a high-level applied study of data mining techniques will be used. *Prerequisite: C-* or better in CSE 3330.

5335. Introduction to Bioinformatics. This course will give the students an up-to-date introduction to the field of bioinformatics. It covers a wide variety of bioinformatics topics from a computer science perspective, including algorithms for DNA/protein sequence analysis, protein 3-D structural alignment, gene expression microarray analysis, Single Nucleotide Polymorphism (SNP)microarray analysis, proteomics data analysis, protein-protein interaction data analysis, pathway data analysis and gene ontology. This course only assumes biology knowledge at the high school level. Some related biological background beyond high school will be included in the lectures. *Prerequisite: C-* or better in CSE 3353 or equivalent, or permission of instructor.

5339. 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. Specific topics include 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: C-* or better in CSE 5343.

5340. Service-Oriented Computing. Service-oriented computing (SOC) 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. *Prerequisites:* Senior or graduate standing. Programming experience is required.

5341. Compiler Construction. Review of programming language structures, loading, execution and storage allocation. Compilation of simple expressions and statements. Organization of a compiler, including compile-time and run-time symbol tables, lexical analysis, syntax analysis, code generation, error diagnostics and simple code optimization techniques. Use of a recursive high-level language to implement a complete compiler. *Prerequisites: C-* or better in CSE 3342 and 3353.

5342. Concepts of Language Theory and Their Applications. Formal languages and their relation to automata. Introduction to finite state automata, context-free languages and Turing machines. Theoretical capabilities of each model, and applications in terms of grammars, parsing and operational semantics. Decidable and undecidable problems about computation. *Prerequisite: C-* or better in CSE 3342 or permission of instructor.

5343. Operating Systems and System Software. Theoretical and practical aspects of operating systems: overview of system software, timesharing and multiprogramming operating systems, network operating systems and the Internet, virtual memory management, interprocess communication and synchronization, file organization, and case studies. *Prerequisites: C-* or better in CSE 2240 and 3353.

5344. Computer Networks and Distributed Systems II. Introduction to network protocols, layered communication architecture, multimedia applications and protocols, Quality of Service (QoS), congestion control, optical networks, DWDM, network survivability and provisioning, and wireless networks. Includes an interdisciplinary project requiring the use of currently available network design and simulation tools. *Prerequisite: C-* or better in CSE 4344.

5345. Advanced Application Programming. The course covers advanced programming techniques that span a range of programming languages and technologies. Topics include server-side application development, client GUI 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.

5346. Java Distributed Enterprise Computing. Familiarizes students with issues and techniques surrounding the building of distributed enterprise Java applications. Initial focus will be on exceptions, threads, streams and sockets in support of building Java-based Web servers. Building on these basic constructs, the course will explore details of enterprise technology, including Java Servlets; Java Server Pages (JSP); database connectivity JDBC; Enterprise JavaBeans; and J2EE for building tightly coupled server components. *Prerequisite:* CSE 5345 or equivalent.

5347. 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 examination of XML as an enterprise technology. Focuses on APIs, interfaces and standards that are driving this technology, including DTDs and XML Schema to structure 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 tradeoffs among different alternatives for processing XML. *Prerequisites:* An understanding of object-oriented concepts and familiarity with Java and/or C++.

5348. Internetworking Protocols and Programming. Processing and Interprocess Communications (IPC), 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: C-* or better in CSE 4344 and 5343 and C programming.

5349. Data and Network Security. Covers conventional as well as state-of-the-art methods in achieving data and network security. Private key and public key encryption approaches will be discussed in detail, with coverage on popular algorithms such as DES, Blowfish and RSA. In the network security area, the course will cover authentication protocols, IP security, Web security and system-level security. *Prerequisite: C-* or better in CSE 4344.

5350. 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. Emphasis on developing student facility to design efficient algorithms. *Prerequisite: C-* or better in CSE 3353.

5356 (EE 5356). VLSI Design and Lab. This laboratory-oriented course for senior and Master's-level graduate students will cover an overview of IC circuit design and fabrication process, basic design rule, and layout techniques. Emphasis will be on digital design. CMOS and NMOS technology will be covered. Each student must complete one or more design projects by the end of the first term. *Prerequisites: C-* or better in EE 2181, 2381 and 3311.

5359. Software Security. As software is delivered across networks 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:* Programming experience in Java and/or C++.

5360. Introduction to 3-D Animation. An introduction to computer graphics, with an emphasis on the popular software package Maya. Includes focus on the user interface, creation of 3-D geometry using polygonal techniques, materials and textures, kinematics, animation, and camera and lighting techniques. This course explores the various aspects and fundamentals of computer graphics. Students gain a core understanding of the workflow necessary to create 3-D imagery. Assignments require students to combine a variety of techniques to become familiar with the computer animation production process. *Prerequisite:* Junior standing or higher. Course may not be used for credit in a graduate degree program in CSE without adviser's approval.

5376 (EETS 5301). 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 antennae, modems and interfaces, and digital transmission systems. T1 carriers, digital microwave, satellites, fiber optics and SONET, and Integrated Services Digital Networks.

5380. VLSI Algorithms. Introduction to 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. Additional focus on constraints for the design for field programmable gate arrays throughout the course. *Prerequisites: C-* or better in CSE 3353 and 3381.

5381. Computer Architecture I. Introduces students to the state of the art in uniprocessor computer architecture. The focus is on the quantitative analysis and cost-performance tradeoffs in instruction-set, pipeline and memory design. Topics covered: quantitative analysis of performance and hardware costs, formal specification, instruction set design, pipeline, delayed branch, memory organization, and advanced instruction-level parallelism. *Prerequisite: C-* or better in CSE 4381.

5382. 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.

5385. Microprocessor Architecture and Interfacing. Emphasizes the design and interfacing of microprocessor computer systems. Topics covered: 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. *Prerequisite: C-* or better in CSE 3381 or EE 3381.

5387 (EE 5387). 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 or EE 2381.

5(1–4)9(0–4). Special Topics. Individual or group study of selected topics in computer science. Variable credit from one to four term hours. Written permission of the supervising faculty member is required before registration.

ELECTRICAL ENGINEERING

Professor Marc P. Christensen, **Chair**

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

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

The Department of Electrical Engineering at SMU offers a full complement of courses at the Bachelor's degree level in communications, networks, digital signal processing, optoelectronics, electromagnetics, microelectronics, and systems and control.

The mission of the department is:

Through quality instruction and scholarly research, engage each student in a challenging electrical engineering education that prepares graduates for the full range of career opportunities in the high-technology marketplace and enables them to reach their fullest potential as a professional and as a member of society.

Departmental goals include:

- Becoming one of the nation's leading electrical engineering departments by building peaks of excellence in the fields of communications/signal processing and micro/optoelectronics and by being a leader in innovative educational programs.
- Offering undergraduate curricula that equips graduates for careers that require ingenuity, integrity, logical thinking, and the ability to work and communicate in teams, and for the pursuit of graduate degrees in engineering or other fields such as business, medicine and law.
- Offering world-class Ph.D. programs that prepare graduates for academic careers, for research careers in the high-technology industry or for technical entrepreneurship.
- Promoting lifelong learning animated by a passion for the never-ending advance of technology.

The educational objectives of the Electrical Engineering Department undergraduate program are to enable graduates to:

- Be successful in understanding, formulating, analyzing and solving a variety of electrical engineering problems.
- Be successful in designing a variety of engineering systems, products or experiments.
- Be successful in careers and/or graduate study in engineering or other areas such as business, medicine and law.
- Have the ability to assume leadership and entrepreneurial positions.

- Successfully function and effectively communicate, both individually and in multidisciplinary teams.
- Understand the importance of lifelong learning, ethics and professional accountability.

The Electrical Engineering Department undergraduate program outcomes as related to the above educational objectives are as follows:

All graduates of the electrical engineering program are expected to have:

a) An ability to apply knowledge of mathematics, science and engineering.
b) An ability to design and conduct experiments, as well as to analyze and interpret data.
c) An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d) An ability to function on multidisciplinary teams.
e) An ability to identify, formulate and solve engineering problems.
f) An understanding of professional and ethical responsibility.
g) An ability to communicate effectively.
h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.
i) A recognition of the need for, and an ability to engage in, lifelong learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

The Electrical Engineering Department is engaged in an ongoing assessment process that evaluates the success in meeting the educational objectives and outcomes and enhances the development of the program.

The undergraduate program in electrical engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone (410) 347-7700.

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

1. **Biomedical Engineering.** Overview of biomedical engineering, biomedical devices and instrumentation, biomedical signal capture, processing, and modeling.
2. **Communications and Information Technology.** Detection and estimation theory, digital communications, computer networks, spread spectrum, cellular communications, coding, encryption, compression, and wireless and optical communications.
3. **Control Systems.** Linear and nonlinear systems control, robotics, and computer and robot vision.
4. **Digital Signal Processing.** Digital filter design, system identification, spectral estimation, adaptive filters, neural networks and DSP implementations.
5. **Image Processing and Computer Vision.** Digital image processing, computer vision and pattern recognition.
6. **Lasers, Optoelectronics, Electromagnetic Theory and Microwave Electronics.** Classical optics, fiber optics, laser recording, integrated optics, dielectric wave guides, antennas, transmission lines, laser diodes and signal processors, and superconductive microwave and optoelectronic devices.

7. **Solid State Circuits, Computer-Aided Circuit Design and VLSI Design.** Electronic circuits, computer-aided design, very-large-scale integration design and memory interfaces.
8. **Electronic Materials and Solid State Devices.** Fabrication and characterization of devices and materials, device physics, noise in solid state devices, infrared detectors, AlGaAs and GaAs devices and materials, thin films, superconductivity, superconductive devices and electronics, hybrid superconductor-semiconductor devices, ultrafast electronics, and applications of a scanning tunneling microscope.
9. **Telecommunications.** Overview of modern telecommunications components and systems, data communications, digital telephony, and digital switching.

Department Facilities

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 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 over 40 servers whose purposes include the following: 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 primary file server allows a user's 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 the Engineering School 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 departments.

Specific department laboratory facilities for instruction and research include:

Antenna Laboratory. 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 a T-Tech milling machine, and a photolithic/chemical etching method is used to make more complex and large antennas. Fabricated antennas are characterized with a Hewlett-Packard 5810B network analyzer. Workstations are available for antenna design and theoretical computation. Radiation characteristics are measured at the University of Texas at Dallas-SMU Antenna Characterization Lab near the UTD 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 electroencephalograms 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 Technologies Inc., a Vision Research Graphics 21-inch Digital Multisync Monitor for displaying visual stimuli, and a Cambridge Research Systems visual stimulus generator capable of generating a variety of stimuli for use in psychophysical and electrophysiological experiments. Ultrasound data can also measured with a

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

Digital Signal Processing Laboratory. Digital signal processors are programmable semiconductor devices that are used extensively in cellular telephones, high-density disk drives and high-speed modems. Courses in this laboratory focus on programming the Texas Instruments TMS320C55, a fixed-point processor, with emphasis on assembly language programming. Topics include implementation of FIR and IIR filters, the fast Fourier transform and a real-time spectrum analyzer.

Networks Laboratory. This laboratory provides the opportunity to simulate and evaluate different network configurations, from local area networks to the Internet. High-end PCs are configured with OPNET and mathematics software to model telecommunications networks and study their performance. The Networks Laboratory is used for instruction in conjunction with several networking courses offered in the department.

Multimedia Systems Laboratory. This facility includes an acoustic chamber with adjoining recording studio to allow high-quality sound recordings to be made. The chamber is sound-isolating with double- or triple-wall sheet rock on all four sides, as well as an isolating ceiling barrier above the drop ceiling. The walls of the chamber have been constructed to be nonparallel to avoid flutter echo and dominant frequency modes. Acoustic paneling on the walls of the chamber are removable and allow the acoustic reverberation time to be adjusted to simulate different room acoustics. The control room next to the acoustic chamber includes a large, 4-foot-by-8-foot acoustic window and 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.

High-speed Wireless Communications Laboratory. The laboratory provides a multitier network testbed for research purposes and also serves as a facility for conducting lab courses on wireless communications and networking. The infrastructure in the lab includes 1) GSM-based cellular network that provides wide range connectivity at medium data rates; 2) IEEE 802.11-based wireless LAN offering high data rates in an office environment; and 3) Bluetooth networks that offers low-cost, short-range and low data rate connections. One of the research focus areas is on investigating the total power efficiency of these heterogeneous networks.

Semiconductor Processing Clean Room. The 2,800 square-foot, class 10,000 clean room, 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, a scanning electron microscope, two contact mask aligners, a thermal evaporator, a plasma asher, a plasma etcher, a turbo-pumped methane hydrogen reactive ion etcher, a four-target sputtering system, a plasma-enhanced chemical vapor deposition reactor, a diffusion-pumped four pocket e-beam evaporator, an ellipsometer, and a profilometer. Other equipment includes a boron-trichloride reactive ion etcher, a chemical-assisted ion-beam etcher and an e-beam evaporator for dielectric deposition. The clean room is capable of processing silicon and compound semiconductors for microelectronic, photonic, nanotechnology devices.

Submicron Grating Laboratory. This laboratory is dedicated to holographic grating fabrication and has the capability of sub tenth-micron lines and spaces. Equipment 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, 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 includes optical spectrum analyzer, an optical multimeter, visible and infrared cameras, an automated laser characterization system for edge-emitting lasers, a manual probe test system for surface-emitting lasers, a manual probe test system for edge-emitting laser die and bars, and a near- and far-field measurement system.

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

Photonic Architectures Laboratory. This laboratory 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.

Curriculum in Electrical Engineering

The undergraduate curriculum in electrical engineering provides the student with basic principles through required courses, and specialization through a guided choice of elective courses.

Areas of Specialization

Due to the extensive latitude in course selection and to the wide variety of courses available within the Department of Electrical Engineering and within the University as a whole, it is possible for the electrical engineering student to concentrate his or her studies in a specific professional area. The areas available include the following:

Biomedical Specialization
Computer Engineering Specialization
Engineering Leadership Specialization
Mathematics Dual Degree Specialization
Physics Dual Degree Specialization
Bachelor of Science in Electrical Engineering

The electrical engineering curriculum is administered by the Department of Electrical Engineering.

The term credit hours within this curriculum are distributed as follows:

		Term Credit Hours
College Requirements:	ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations and Wellness	23
Mathematics:	MATH 1337, 1338, 2339, 2343 and a three-hour elective course to be chosen from MATH 3308, 3315, 3337 3353 or CSE 3365	15
Science:	CHEM 1303; PHYS 1303, PHYS 1304, PHYS 1105 or PHYS 1106; and a three-hour elective of PHYS 3305, PHYS 3344, PHYS 3374 or CHEM 1304	13
Computer Science:	CSE 1341 and 1342	6
Engineering Leadership:	One of EMIS 3308, CEE 3302, EMIS 3309 or CSE 4360	3
Engineering Elective:	One of ME 2310, 2320, 2331, 2342, CSE 2341, 2353, EMIS 2360, or any 5000 level EE course approved by the student's adviser	3
Core Electrical Engineering:	EE 1322, 1382, 2122, 2170, 2181, 2322, 2350, 2370, 2381 and 3360	24
Junior Electrical Engineering Courses:	EE 3122, 3181, 3322, 3381, 3311, 3330 and 3372	17
Advanced Electrical Engineering Electives:		15
Senior Design Sequence:	EE 4311 and 4312	6
	Minimum total hours required	**125**

Three hours of advanced electrical engineering electives must be selected in each of the three areas listed below:

EE 5360, 5362, 5370, 5371, 5372, 5373, 5374, 5375 and 5376
EE 5356, 5357, 5381, 5385 and 5387
EE 5310, 5312, 5314, 5321, 5330, 5332 and 5333

The remaining six hours of advanced electrical engineering electives may be chosen from any of the above three areas or advanced (5000-level) CSE courses offered by the CSE Department with the approval of the student's adviser. Please note that EE 8000-level courses are primarily for graduate students but may be taken by highly qualified undergraduates with the approval of the adviser and the instructor. Special topics courses also are available.

Each student is expected to complete and file a plan of study with his or her academic adviser. The plan should state specific choices to meet the foregoing requirements and develop an area of specialization when this is desired. This should be done as soon as possible; however, for many students, it is a process that continues from term to term as the individual becomes better acquainted with the discipline of electrical engineering and with the choices available.

Specializations are offered in five important areas: premedical or biomedical engineering, computer engineering, a dual degree in physics, a dual degree in mathematics, and engineering leadership. Each student may select one of these specializations or may personalize his or her degree by a particular choice of advanced major electives.

Bachelor of Science in Electrical Engineering
(Biomedical Specialization)

The Department of Electrical Engineering offers a B.S.E.E. degree with a specialization in biomedical engineering. This program enables students to satisfy requirements for admission to medical school.

The term credit hours within this curriculum are distributed as follows:

		Term Credit Hours
College Requirements:	ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations and Wellness	23
Mathematics:	MATH 1337, 1338, 2339, 2343 and a three-hour elective course at the 3000 level or above	15
Science:	BIOL 1401, 1402, 3304 and 3350; CHEM 1303, 1304, 1113, 1114, 3117, 3118, 3371 and 3372; and PHYS 1105, 1106, 1303 and 1304	38
Computer Science:	CSE 1341 or CSE 1342	3
Core Electrical Engineering:	EE 1322, 1382, 2122, 2170, 2181, 2322, 2350, 2370, 2381, 3181, 3360, 3372 and 3381	31
Junior Electrical Engineering:	Two courses from EE 3311, EE 3122/3322 or EE 3330	6
Advanced Electrical Engineering Elective:	Any EE 5000-level course approved by the student's adviser	3
Biomedical Engineering:	EE 5340 and 5345	6
Senior Design Sequence:	EE 4311, 4312	6
	Minimum total hours required	**131**

Bachelor of Science in Electrical Engineering
(Computer Engineering Specialization)

The Department of Electrical Engineering offers a B.S.E.E. degree with a computer engineering specialization, which brings together aspects of electrical engineering and computer science with the aim of developing state-of-the-art digital computer systems. Students in the computer engineering specialization receive training in a variety of areas ranging from C programming, assembly language and data structures, to logic design, microprocessor interfacing and computer architecture.

The term credit hours within this curriculum are distributed as follows:

		Term Credit Hours
College Requirements:	ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations and Wellness	23
Mathematics:	MATH 1337, 1338, 2339, 2343 and one of MATH 3315/CSE 3365, MATH 3337 or 3353	15
Science:	CHEM 1303, PHYS 1303, PHYS 1304, and PHYS 1105 or PHYS 1106, plus one three-hour elective chosen from CHEM 1304, PHYS 3305, PHYS 3344 and PHYS 3374	13
Computer Science:	CSE 1341, 1342, 2341, 2353 and 3358	15

(Continued)

Core Electrical Engineering:	EE 1322, 1382, 2122, 2170, 2181, 2322, 2350, 2370, 2381 and 3360	24
Junior Electrical Engineering Courses:	EE 3122, 3181, 3311, 3322, 3330, 3372 and 3381	17
Advanced Electrical Engineering Electives:	EE 5381, 5385 and two of EE 5357, EE 5387 or CSE 5343	12
Senior Design Sequence:	EE 4311 and 4312	6
	Minimum total hours required	**125**

Bachelor of Science in Electrical Engineering
(Engineering Leadership Specialization)

This specialization prepares graduates to be highly educated engineers with the appropriate interdisciplinary knowledge to assume important management and leadership positions and to become technical entrepreneurs in a globally competitive world.

The term credit hours within this curriculum are distributed as follows:

		Term Credit Hours
College Requirements:	ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations and Wellness	23
Mathematics:	MATH 1337, 1338, 2339, 2343 and a three-hour elective course at the 3000 or above level	15
Science:	CHEM 1303; PHYS 1303, PHYS 1304 and PHYS 1105 or PHYS 1106; and one three-hour elective chosen from CHEM 1304, PHYS 3305, PHYS 3344 or PHYS 3374	13
Computer Science:	CSE 1341 and 1342	6
Engineering Leadership:	Three of CEE 3302, EMIS 3308, 3309 and CSE 4360	9
Engineering Elective:	One of ME 2310, ME 2320, ME 2331, ME 2342, CSE 2341, CSE 2353, EMIS 2360 or any EE 5000-level course approved by the student's adviser	3
Core Electrical Engineering:	EE 1322, 1382, 2122, 2170, 2181, 2322, 2350, 2370, 2381 and 3360	24
Junior Electrical Engineering Courses:	EE 3122, 3181, 3311, 3322, 3330, 3372 and 3381	17
Advanced Electrical Engineering Electives:	Three 5000-level courses (one in each of the areas listed below) approved by the student's adviser	9
Senior Design Sequence:	EE 4311 and 4312	6
	Minimum total hours required	**125**

Three hours of advanced electrical engineering electives must be selected in each of the three areas listed below:

EE 5360, 5362, 5370, 5371, 5372, 5373, 5374, 5375 and 5376
EE 5356, 5357, 5381, 5385 and 5387
EE 5310, 5312, 5314, 5321, 5330, 5332 and 5333

Bachelor of Science in Electrical Engineering and Bachelor of Science with a Major in Mathematics

The Electrical Engineering Department and the Mathematics Department offer an integrated curriculum that enables a student to obtain both a B.S.E.E. degree and a B.S. degree with a major in mathematics. The term credit hours within this curriculum are distributed as follows:

		Term Credit Hours
College Requirements:	ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations and Wellness	23
Mathematics:	MATH 1337, 1338, 2339, 2343, 3315, 3337, 3353; three hours from 5315, 5325, 5331, 5332 or 5334	24
Science:	CHEM 1303; PHYS 1303, PHYS 1304, and PHYS 1105 or PHYS 1106	10
General Engineering:	CSE 1341 and 1342	6
Core Electrical Engineering:	EE 1322, 1382, 2122, 2170, 2181, 2322, 2350, 2370, 2381 and 3360	24
Junior Electrical Engineering:	EE 3122, 3181, 3311, 3322, 3330, 3372, and 3381	17
Advanced Electrical Engineering Electives:	Three hours of advanced electrical engineering electives must be selected in each of the three areas listed below: EE 5360, 5362, 5370, 5371, 5372, 5373, 5374, 5375 or 5376 EE 5356, 5357, 5381, 5385 or 5387 EE 5310, 5312, 5314, 5321, 5330, 5332 or 5333 The remaining six hours may be chosen from any EE or CSE 5000-level courses with the approval of the student's adviser.	15
Senior Design Sequence:	EE 4311 and 4312	6
	Minimum total hours required	**125**

Bachelor of Science in Electrical Engineering and Bachelor of Science with a Major in Physics

The Electrical Engineering Department and the Physics Department offer an integrated curriculum that enables a student to obtain both a B.S.E.E. degree and a B.S. degree with a major in physics.

The term credit hours within this curriculum are distributed as follows:

		Term Credit Hours
College Requirements:	ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations and Wellness	23
Mathematics:	MATH 1337, 1338, 2339, 2343 and 3315	15
Science:	CHEM 1303; PHYS 1105 or PHYS 1106, 1303, 1304, 3305, 3344, 4211, 4321, 5337, 5382 and 5383; and PHYS 3374 or ME 3341	33
Computer Science:	CSE 1341 or CSE 1342	3
Core Electrical Engineering:	EE 1322, 1382, 2122, 2170, 2181, 2322, 2350, 2370, 2381, 3360 and 3372	27
Junior Electrical Engineering Courses:	EE 3122, 3181, 3311, 3322, 3381, either EE 3330 or PHYS 4392	14

(Continued)

Advanced Electrical Engineering Electives:	Three hours of advanced electrical engineering electives must be selected in each of the three areas listed below: EE 5360, 5370, 5371, 5372, 5373, 5374 or 5376 EE 5356, 5357, 5381, 5385 or 5387 EE 5310, 5312, 5314, 5321, 5330, 5332 or 5333	9
Senior Design Sequence:	EE 4311 and 4312	6
	Minimum total hours required	**130**

Minor in Electrical Engineering

For information on a minor in electrical engineering, the student should consult the department. A total of 18 term credit hours in electrical engineering courses is necessary to meet the following requirements:

Requirements

EE 2322 Electronic Circuits I
EE 3322 Electronic Circuits II
EE 2350 Circuit Analysis I
EE 2370 Design and Analysis of Signals and Systems

Elective Courses

Six term credit hours of electrical engineering courses at the 3000 level or above

The Courses (EE)

The third digit in a course number designator is representative of the subject area represented by the course. The following designators are used:

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
EETS XX0X Telecommunications

1301. Modern Electronic Technology. A lecture and laboratory course examining a number of topics of general interest, including the fundamentals of electricity, household electricity and electrical safety, an overview of microelectronics, concepts of frequency and spectrum, the phonograph and the compact disc, bar codes, and communication by radio and television. Meets the science/technology laboratory course requirement of the General Education Curriculum. The course is designed for nontechnical students who want to be more knowledgeable. (Not open to EE majors.)

1322. Survey of Electrical and Electronic Devices. This course offers beginning electrical engineering students an introduction to contemporary electrical and electronic devices, including transformers, alternators, generators, motors, relays, loudspeakers, vacuum tubes, transistors, light-emitting diodes, photodetectors and integrated circuits. Students learn how these devices are used in contemporary products. They also will research a device type, build a circuit application and reverse-engineer a product. *Prerequisites:* Admission as an engineering or physics student is recommended, but not required; some knowledge of calculus would be helpful.

1382. Fundamentals of Electrical Engineering. Introduces engineering students to the fundamentals of modern electrical engineering. The material covers the basics of the creation, manipulation, storage and transmission of information in electronic form. Topics will include time and frequency domain signal analysis, mathematics and physics of basic building blocks of electrical systems, sampling, filtering, data coding for compression and reliability, communications, digital imaging, and storage technologies. Weekly laboratory and design assignments will be an integral part of the course.

2122. EE Laboratory: Electronic Circuits I. Experimental study of basic MOS and bipolar transistors in analog and digital applications. Logic gates and linear and nonlinear applications of operational amplifiers. *Prerequisite: C-* or better in EE 2350. *Corequisite:* EE 2322.

2170. EE Laboratory: Design and Analysis of Signals and Systems. This laboratory course introduces students to various techniques for analyzing real signals and designing various linear time-invariant, continuous-time systems. The labs incorporate both software-based simulations and actual circuit implementations. Web authoring tools are used for the production of multimedia lab reports. *Prerequisite:* CSE 1341. *Corequisite:* EE 2370.

2181. EE Laboratory: Digital Computer Logic. Analysis and synthesis of combinational and sequential digital circuits. Basic digital computer logic circuits are designed, simulated using Verilog HDL and implemented using a Digi-Designer kit and integrated circuits. *Corequisite:* EE 2381.

2322. Electronic Circuits I. An introduction to nonlinear devices used in electronic circuits. The course will cover the DC and AC analysis of circuits employing diodes, bipolar junction transistors (BJTs) and MOSFETs. Topics include device I-V characteristics, biasing, transfer characteristic, gain, power dissipation, and the design of amplifier circuits and logic circuits. The SPICE simulation will also be introduced in this course for DC and transient simulations. *Prerequisite: C-* or better in EE 2350. *Corequisite:* EE 2122.

2350. Circuit Analysis I. Analysis of resistive electrical circuits, basic theorems governing electrical circuits, power consideration and analysis of circuits with energy storage elements. Transient and sinusoidal steady-state analysis of circuits with inductors and capacitors. *Corequisites:* PHYS 1304 and MATH 2343.

2370. Design and Analysis of Signals and Systems. This course introduces students to standard mathematical tools for analyzing and designing various continuous-time signals and systems. Frequency domain design and analysis techniques are studied, as well as the Fourier and Laplace transforms. Applications to be studied include modulation and demodulation in communications and processing audio signals. *Prerequisites: C-* or better in EE 2350, and MATH 2343. *Corequisite:* EE 2170.

2381. Digital Computer Logic. Digital computers and information; combinational logic circuits; combinational logic design; sequential circuits, including finite-state machines; registers and counters; and memory and programmed logic design. Design and simulation of digital computer logic circuits are studied. *Corequisite:* EE 2181.

3(1–3)90. Junior Project.

3122. EE Laboratory: Electronic Circuits II. Experiments in analog electronic circuit design. *Prerequisites: C-* or better in both EE 2122 and EE 2322. *Corequisite:* EE 3322.

3181. EE Laboratory: Microprocessors. Fundamentals of microprocessor design and assembly-language programming. An introduction to the HCS12 Freescale processors, CodeWarrior assembler, microprocessor-based system design, assembly programming and hardware interfacing. *Prerequisites: C-* or better in both EE 2181 and EE 2381. *Corequisite:* EE 3381.

3311. Solid-State Devices. This laboratory-oriented elective course introduces undergraduates to the working principles of semiconductor devices by fabricating and testing silicon MOSFET transistors and III-V based semiconductor lasers in the SMU clean room. Lectures will explain the basic operation of diodes, bipolar transistors, field effect transistors, light-emitting diodes, semiconductor lasers and other photonic devices. Additional lectures will discuss the basics of device processing, which include photolithography, oxidation, diffusion, ion-implantation, metallization and etching. Laboratory reports describing the fabrication and testing of devices will account for a major portion of the course grade. *Prerequisites: C-* or better in EE 2350, and CHEM 1303.

3322. Electronic Circuits II. Introduction to MOSFET analog electronic circuits. The course is designed to provide the student with a background for understanding modern electronic circuits such as digital-to-analog and analog-to-digital converters, active filters, switched-capacitor circuits, and phase-locked loops. Topics include MOSFET SPICE models, basic MOSFET, single-stage amplifiers, current-mirrors, differential amplifier stages, source-follower buffer stages, high-gain common-source stages, operational amplifier, frequency response and negative feedback. *Prerequisites: C-* or better in the following: EE 2322, EE 2122 and EE 2350. *Corequisite:* EE 3122.

3330. Electromagnetic Fields and Waves. Vector analysis applied to static electric and magnetic fields, development of Maxwell's equations, elementary boundary-value problems, and determination of capacitance and inductance. Introduction to time-varying fields, plane waves and transmission lines. *Prerequisites: C-* or better in EE 2350, and MATH 2339, or permission of the instructor.

3360. Statistical Methods in Electrical Engineering. This course is an introduction to probability, elementary statistics and random processes. Topics include fundamental concepts of probability, random variables, probability distributions, sampling, estimation, elementary hypothesis testing, basic random processes, stationarity, correlation functions, power-spectral-density functions, and the effect of linear systems on such processes. *Prerequisites: C-* or better in both EE 2370 and EE 2170.

3372. Introduction to Digital Signal Processing. This course is designed to give juniors a thorough understanding of techniques needed for the analysis of discrete-time signals. Topics include Fourier methods and Z-transform techniques, discrete Fourier transform, fast Fourier transform and applications, and digital filters. *Prerequisites: C-* or better in both EE 2370 and EE 2170.

3381. Microprocessors. An introduction to microprocessors and microcomputers. The Freescale HCS12 processors are used to introduce architecture, software and interfacing concepts. Topics include number systems and arithmetic operations for computers, assembly language programming, microprocessor organization and operation, memory and I/O port interfacing, and microprocessor-based controller design. Students will write, assemble and execute microprocessor programs. *Prerequisite: C-* or better in EE 2381. *Corequisite:* EE 3181.

4(1–3)90. Senior Project.

4311. Senior Design I. Areas covered in this course will be tailored to the student's area of specialization. The design project segment of this course involves choosing a specific senior design project in electrical engineering from the available projects proposed by the faculty. Depending upon the specifics of the project, each student will design, construct and test a solution, and submit a formal report to the faculty in charge of the project. *Prerequisite:* EE senior standing.

4312. Senior Design II. Areas covered in this course will be tailored to the student's area of specialization. The design project selected in this course may be a continuation of the project undertaken in EE 4311, a new project selected from the list of available projects offered by the faculty, or a project proposed by the student and approved by the faculty. Depending upon the specifics of the project, a team will design, construct and test a solution, and submit a formal report to the faculty in charge of the project. *Prerequisite:* EE 4311.

5050. Undergraduate Industrial Internship.

5(1–3)9(0–9). Special Topics. This special-topics course must have a section number associated with a faculty member. The second digit corresponds to the number of term credit hours, which ranges from one to three. The last digit ranges from zero to nine and represents courses with different topics.

5176. Network Simulation Lab. Introductory hands-on course in simulations of computer networks, intended to be taken simultaneously with EE 5376 or other networks courses. Lab exercises use OPNET and other simulation software to visualize network protocols and performance. Students run a number of simulation exercises to set up various network models, specify protocols and collect statistics on network performance. These exercises will be designed to complement classroom instruction. General familiarity with PCs is recommended. *Prerequisite:* Senior standing. *Corequisite:* EE 5376.

5310. Introduction to Semiconductors. A study of the basic principles in physics and chemistry of semiconductors that have direct applications on device operation and fabrication. 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. *Prerequisites:* EE 3311 or equivalent, graduate standing, or permission of the instructor.

5312. Semiconductor Processing Laboratory. This is a laboratory-oriented elective course for upper-level undergraduates and graduate students, providing in-depth coverage of processing of InP and GaAs compounds in addition to silicon integrated circuit processing. Students without fabrication experience will fabricate and characterize MOSFETs and semiconductor lasers. Students with some previous fabrication experience (such as EE 3311) will fabricate and test an advanced device mutually agreed upon by the student(s) and the instructor. Examples of such devices include High Electron Mobility Transistors (HEMTs), Heterojunction Bipolar Transistors (HBTs), phase shifters, distributed Bragg reflector (DBR) 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. *Prerequisites:* EE3311 or equivalent, graduate standing, or permission of the instructor. EE 5310 is recommended but not required.

5314. Introduction to Microelectromechanical Systems (MEMS) and Devices. 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 film technologies as they apply to MEMS. *Prerequisite:* EE 3311.

5321. Semiconductor Devices and Circuits. A study of the basics of CMOS integrated analog circuits design. Topics include MOSFET transistor characteristics, DC biasing, small-signal models, different amplifiers, current mirrors, single- and multistage electronic amplifiers, frequency response of electronic amplifiers, amplifiers with negative feedback, and stability of amplifiers. Each student will complete one or more design projects by the end of the course. *Prerequisites:* EE 3122 and EE 3322.

5330. Electromagnetics: Guided Waves. Topics include application of Maxwell's equations to guided waves; transmission lines, and plane wave propagation and reflection; hollow waveguides and dielectric waveguides; fiber optics; and cavity and dielectric resonators. *Prerequisite:* EE 3330.

5332. Electromagnetics: Radiation and Antennas. This course covers polarization, reflection, refraction and diffraction of EM waves; dipole, loop and slot/reflector antennas; array analysis and synthesis; self and mutual impedance; and radiation resistance. *Prerequisite:* EE 3330.

5333. Antennas and Radiowave Propagation for Personal Communications. 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.

5336. 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 on 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; nonlinear effects; numerical methods; and coupled mode theory. Mathematical packages such as MATLAB and/or Mathematica will be used extensively in this class. *Prerequisites: C-* or better in both EE 3311 and EE 3330, or permission of instructor.

5340. Biomedical Instrumentation. Application of engineering principles to solving problems encountered in medicine and biomedical research. Topics include transducer principles, electrophysiology and cardiopulmonary measurement systems. *Prerequisites: C-* or better in both EE 2122 and EE 2322.

5345. Medical Signal Analysis. A look 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. *Prerequisite:* EE 3372.

5356 (CSE 5356). VLSI Design and Lab. Laboratory-oriented course for senior and Master's-level graduate students will cover an overview of integrated circuit design and fabrication, basic design rules, and layout techniques. Emphasis will be on digital design. CMOS and NMOS technology will be covered. Each student must complete one or more design projects by the end of the first term. *Prerequisites: C-* or better in both EE 2181 and EE 2381, and EE 3311.

5357. CAE Tools for Structured Digital Design. Concentrates on the use of CAE tools for the design and simulation 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. *Prerequisites: C-* or better in both EE 2181 and EE 2381.

5360. Analog and Digital Control Systems. Feedback control of linear continuous and digital systems in the time and frequency domain. Topics include plant representation, frequency response, stability, root locus, linear state variable feedback and design of compensators. *Prerequisite:* EE 3372.

5362 (ME 5302). Linear Systems Analysis. Topics include state-space representation of continuous and discrete-time systems, controllability, observability and minimal representations; and linear-state variable feedback, observers and quadratic regulator theory. *Prerequisite:* EE 3372.

5370. Communication and Information Systems. An introduction to communication in modulation systems in discrete and continuous time, information content of signals, and the transition of signals in the presence of noise. Amplitude, frequency, phase and pulse modulation. Time and frequency division multiplexing. *Prerequisite:* EE 3360 or equivalent.

5371. Analog and Digital Filter Design. Approximation and analog design of Butterworth, Chebyshey and Bessel filters. Basic frequency transformations for designing low-pass, band-pass, band-reject and high-pass filters. Concept of IIR digital filters using impulse-invariant and bilinear transformations. Design of FIR digital filters using frequency sampling and window methods. Canonical realization of IIR and FIR digital filters. Wave digital filters. Introduction to 2-D filters. *Prerequisite:* EE 3372.

5372. Topics in Digital Signal Processing. This course is intended to provide 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 multirate signal processing, digital filter structures, filter design and power spectral estimation. *Prerequisite:* EE 3372.

5373. DSP Programming Laboratory. Digital signal processors (DSPs) are programmable semiconductor devices used extensively in digital cellular phones, high-density disk drives and high-speed modems. This laboratory course focuses on programming the Texas Instruments TMS320C55, a fixed-point processor. The emphasis is on assembly language programming, and the laboratories utilize a hands-on approach that will focus on the essentials of DSP programming while minimizing signal processing theory. Laboratory topics include implementation of FIR and IIR filters, the FFT, and a real-time spectrum analyzer. *Suggested:* Some basic knowledge of discrete-time signals and digital logic systems. *Prerequisite:* EE 3372.

5374. 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 5372.

5375. 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:* EE 3360.

5376. Introduction to Communication Networks. 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 (IP), TCP and ATM protocol. Assignments may include lab exercises involving computer simulations. *Prerequisite:* Senior standing. *Corequisite:* EE 5176.

5377. Wireless Communications and Lab. This course exposes students to a wide variety of real-world experiences in wireless communications. Basic concepts of channel coding, modulation and power control will be studied using specific examples from cellular and wireless LAN systems. Diversity and multiple access aspects of these systems will also be covered. Lab experiments include 1) study of signaling modes and transmission schemes in GSM and characterizing the performance; 2) understanding the basic anatomy of a voice call in GSM; 3) data throughput study in IEEE 802.11-based wireless LANs; and 4) device discovery, topology management and data transfer in Bluetooth networks. *Prerequisite:* EE 3360 or equivalent.

5381. Digital Computer Design. Emphasizes design of digital systems and register transfer. Design conventions, addressing modes, interrupts, input-output, channel organization, high-speed arithmetic, and 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: C-* or better in both EE 2181 and EE 2381. Junior standing.

5385. Microprocessors in Digital Design. Intended to help prepare the digital design engineer for utilization of microprocessors as programmable logic components in digital systems design. Topics include fundamentals of hardware and software engineering and their interrelationship with the microprocessor, capabilities and limitations of the Freescale 32-bit microprocessor family, use of hardware/software development systems, assembly language programming for ColdFire, input-output interfacing, and concepts involved in real-time applications. Also, features of similar processors will be covered. Each student will complete one or more laboratory projects by the end of the course. *Prerequisites: C-* or better in both EE 3181 and EE 3381.

5387 (CSE 5387). 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 either EE 2381 or CSE 3381.

Telecommunication Courses (EETS)

5301 (CSE 5376). 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. T1 carriers, digital microwave, satellites, fiber optics and SONET, and the Integrated Services Digital Network. *Prerequisite:* Junior standing.

5302. Telecommunications Management and Regulation. The managerial sequel to EETS 5301. Provides a historical review of the most significant regulation and management issues affecting the telecommunications industry over the past 100 years. Also explores the regulatory environment the telecommunications industry operates in today through the study of current events, articles, and recent state and federal legislation. *Prerequisite:* EETS 5301 (formerly EE 5301).

5303. Fiber Optic Telecommunications. 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. *Prerequisite:* Junior standing.

5304. Internet Protocols. This course is an introductory 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 the ATM protocol. The second part of this 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 5301 (formerly EE 5301) or equivalent.

ENGINEERING MANAGEMENT, INFORMATION AND SYSTEMS

Associate Professor Richard S. Barr, **Chair**

Professors: Margaret H. Dunham (Computer Science), Jeffery L. Kennington, Stephen Szygenda, Jeff Tian (Computer Science). **Associate Professors:** Richard V. Helgason, Eli V. Olinick, Jerrell Stracener. **Assistant Professor:** Junfang Yu. **Senior Lecturer:** Thomas Siems. **Lecturers:** Leslie-Ann Asmus, Gretchen Coleman, Mary Alys Lillard. **Adjunct Faculty:** Karl Arunski, Christopher Askew, John Baschab, Charles Beall, Robert Bell, William David Bell, Ann Broihier, Jean Chastain, George Chollar, Eric Cluff, Kevin Cluff, David Cochran, Howard Cowin, Gunter Daley, Christopher Davis, Peter DeLisle, Dennis Delzer, Matthew Durchholz, Dennis Frailey, Ganesh Harpavat, James Hinderer, Michael Hopper, Gerard Ibarra, Robert Jones, Jan Lyons, Dario Nappa, Robert Oshana, David Peters, Oscar K. Pickels, Jon Piot, James Rodenkirch, Christopher Rynas, Mark Sampson, Steven P. Sanazaro, Nandlal Singh, Stephen Skinner, Gheorghe Spiride, William Swanson, John Via, Daniel Wiebelhaus, John Yarrow, Hossam Zaki. ***Emeritus* Professor:** U. Narayan Bhat (Statistics).

The Department of Engineering Management, Information and Systems brings together the school's technical management and operations areas to offer a Bachelor of Science with a major in management science. This academic program in management science focuses on computer models for decision-making and 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, quality control, reliability engineering, information engineering, benchmarking, operations planning and management, network optimization, and mathematical programming.

The same systems-oriented, mathematical-model-based approach that is the cornerstone of engineering also has powerful application within organizations and their operations. This is the field of management science – also termed "the science of better" – the discipline of applying advanced analytical methods to help make better decisions.

Curriculum in Management Science

Management science deals with the development of mathematically based models for planning, managing, operating and decision-making. In the EMIS curriculum, these methods are also applied to the design and management of efficient systems for producing goods and delivering services.

A management scientist at a major airline would be concerned with building mathematical models to decide the best flight schedules, plane routes, and assignments of pilots and crews to specific flights and of flights to specific gates, as well as the best number of planes to own and operate, cities to fly to, cities to use as major hubs, layout for an airport terminal, overbooking policy, and location to refuel aircraft. Optimal and good usable solutions for such issues can be uncovered through analysis with computer-based mathematical models. The management scientist develops an understanding of a practical decision problem, then designs and constructs a model that incorporates data from the MIS department and produces a high-quality solution.

Because of its generality, management science has broad applications in all engineering disciplines and in the fields of computer science, economics, finance, marketing, medicine, logistics, production, information engineering and statistics. Management science methods are used extensively in industry and government, and SMU's EMIS program prepares the technically oriented student to excel in today's competitive business environment.

ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700, does not provide accreditation for the discipline of management science.

Bachelor of Science With a Major in Management Science

Curriculum Requirements		*Term Credit Hours*
Liberal Studies:	ENGL 1301, 1302	6
	Perspectives	15
	Cultural Formations	6
	(One Perspectives course *or* one Cultural Formations course must satisfy the human diversity requirement.)	
Mathematics:	MATH 1337, 1338, 3315, 3353	12
Science:	Three term credit hours in natural science from group 1	3
	Three term credit hours in natural science or technology from groups 1 and 2	3
	Nine term credit hours in natural science, technology and/or social science from groups 1, 2 and 3	9
	Group 1:	
	BIOL 1303, 1304, 1305, 1308, 1310, 1401, 1402	
	CEE 1331	
	CHEM 1303/1113, 1304/1114	
	GEOL 1301, 1305, 1307, 1308, 1313, 1315, 2320	
	PHYS 1303/1105, 1304/1106, 1307/1105, 1308/1106, 1320	
	Group 2:	
	ANTH 2315, 2363	
	CEE 1301, 1378	
	CSE 1331	
	EE 1301, 1382	
	ME 1301, 1202/1102, 1303	
	PHYS 1403, 1404	
	Group 3:	
	Other courses in ANTH, ECO, PSYC or SOCI	
Major Concentration:	EMIS 1360, 2360, 3308, 3309, 3340, 3360, 3361, 4395, 5362	
	CEE 3302	
	CSE 1341, 1342, 4360	

(Continued)

	Three term credit hours from EMIS courses at the 5000 level or above	42
Business:	ACCT 2301, MKTG 3340, MNO 3370	9
Electives:	Adviser must approve electives	15
Wellness:		2
	Minimum total hours required	**122**

NOTE: *All management science majors must receive a grade of at least C- in all mathematics and major concentration courses taken in fulfillment of the requirements for the major.*

Example Program. The following is a typical schedule of classes for a management science major and takes into account course prerequisites and standard terms that individual classes are offered. Alternative schedules are possible and can be designed in consultation with the EMIS undergraduate adviser.

First year:

Fall	*Spring*
MATH 1337	MATH 1338
ENGL 1301	ENGL 1302
EMIS 1360	ECO 1312
ECO 1311	CSE 1342
CSE 1341	Natural Science (Group 1)
Wellness	Wellness

Second year:

Fall	*Spring*
EMIS 2360	EMIS 3340
Science/Tech (Group 2)	Science/Tech (Group 3)
MATH 3353	Math 3315
Perspectives	ACCT 2301
Perspectives	Perspectives

Third year:

Fall	*Spring*
EMIS 3360	EMIS 3361
EMIS 3308	EMIS 3309
Cultural Formations	CEE 3302
Perspectives	Perspectives
Science (Group 3)	Cultural Formations

Fourth year:

Fall	*Spring*
EMIS 5362	EMIS 4395
CSE 4360	EMIS 53XX
MKTG 3340	MNO 3370
Elective	Elective
Elective	Elective

Minor in Management Science

For information on a minor in management science, the student should consult the department. A total of 18 term credit hours in management and computer science courses is necessary to meet the following requirements:

EMIS 1360 Introduction to Management Science
EMIS 2360 Engineering Economy
EMIS 3360 Operations Research
EMIS 5362 Production Systems Engineering
CSE 1341 Introduction to Computing Concepts

Plus one (1) of the following:
EMIS 3340 Statistical Methods for Engineers and Applied Scientists
EMIS 5370 Probability and Statistics for Scientists and Engineers
EMIS 4395 Senior Design

Dual Degree Programs and the 4+1 Program

Because of the flexibility of the curriculum, a majority of management science majors choose to receive a second major or one or more minors from a wide range of other disciplines. Examples include a Bachelor of Science; a major in management science; or a second Bachelor's degree in economics, mathematics, business, computer science, history, psychology, Spanish or French.

Other management science majors continue their studies to obtain a Master's of Science in Engineering Management, systems engineering, information engineering or operations research. The 4+1 Program permits management science majors to obtain both undergraduate and graduate degrees in a shorter time and with fewer courses than if taken separately or from different universities.

More information on these and other options available to management science majors can be found on the EMIS Department's website: www.engr.smu.edu/emis. EMIS faculty and advisers are also available to answer questions about the program.

Computing Facilities

Students in the EMIS Department have access to a wide range of computing facilities and networking equipment. The department manages three PC-based computing labs, including the Enterprise Systems Design Laboratory created for students in the senior design course. General-use UNIX and Linux machines (including eight-processor 64-bit Xeon workstations) provide advanced computing, analytical software and Web hosting to all engineering students. Windows- and Linux-based PCs and workstations are the primary desktop equipment. All computing facilities are networked via high-speed Ethernet, with Gigabit Ethernet connections to Internet 1, Internet 2 and the National Lambda Rail research network. Open computing labs and wireless services provide additional facilities access points for students.

The Courses (EMIS)

1305. Computers and Information Technology. A survey course in computers and information technology that introduces the college student to the architecture of the personal computer, software, hardware, telecommunications and artificial intelligence, as well as the social and ethical implications of information technology. The two-hour laboratory sessions reinforce the concepts learned in lecture, including a survey of word processing, spreadsheet, database management, presentation and network software. Credit is not allowed for a computer science, computer engineering, or management science major or minor. Credit is not allowed for both EMIS 1305 and EMIS 1307.

1307. Information Technology in Business. Today, computer literacy is essential to a career in any field, but nowhere is it more crucial than in the business field. This course focuses on the use of information technology in business. This course will explain the computer system and the relationship of its parts to each other. It will define the terms used by technologists and instill an appreciation for the effect of information technology on our lives and livelihood. The lab component of the course introduces the student to major productivity software packages, provides the fundamental knowledge that is a requirement for a business major and allows the student to explore the benefits that technology can bring. No credit for an EMIS major or minor. Credit is not allowed for both EMIS 1305 and 1307.

1360. Introduction to Management Science. Management science is the application of mathematical modeling and scientific principles to solve problems and improve life in society. This introductory class shows how to develop plans, manage operations and solve problems encountered in business and government today. *Prerequisite:* Knowledge of college-level algebra. (Must enroll in lab.)

2360. Engineering Economy. Evaluation of engineering alternatives by equivalent uniform annual cost, present worth and rate-of-return analysis. Use of a computerized financial planning system. 0.5 TCH Design. Credit is not allowed for both EMIS 2360 and EMIS 8361. *Prerequisite: C-* or better in MATH 1337. (Must enroll in lab.)

3150. Ethics in Computing. Computer professionals have a special responsibility to ensure ethical behavior in the design, development, and use of computers and computer networks. This course focuses on the education of the undergraduate through the study of ethical concepts and the social, legal and ethical implications involved in computing. Issues to be studied include computer crimes, software theft, hacking and viruses, intellectual property, unreliable computers, technology issues in the workplace, and professional codes of ethics. *Prerequisite:* Junior standing.

3308. Engineering Management. Examines planning, financial analysis, organizational structures, management of the corporation (including its products, services and people), transfer of ideas to the marketplace, ethics and leadership skills. Credit is not allowed for both EMIS 3308 and EMIS 5351. *Prerequisite:* Junior standing.

3309. Information Engineering and Global Perspectives. Examines global and information aspects of technology- and information-based companies. *Prerequisite:* Junior standing. (Must enroll in lab.)

3340 (CSE 4340, STAT 4340). Statistical Methods for Engineers and Applied Scientists. Basic concepts of probability and statistics useful in the solution of engineering and applied science problems. Topics: probability, probability distributions, data analysis, sampling distributions, estimations and simple tests of hypothesis. *Prerequisite: C-* or better in MATH 1338.

3360. Operations Research. A survey of deterministic models and methods of operations research in a variety of areas will be covered. Credit is not allowed for both EMIS 3360 and EMIS 8360. *Prerequisite:* EMIS 1360. (Must enroll in lab.)

3361. Stochastic Models in Operations Research. EMIS 3361 is the second course in a two-course sequence in Operations Research. It covers formulation and application of probabilistic and statistical models for solving problems in the design and management of efficient systems for producing goods and delivering services. Where appropriate, deterministic formulations for such problems addressed in EMIS 3360 are extended by modeling of uncertainty to provide additional information and insights useful to a planner or decision-maker beyond what they are able to attain when assuming only deterministic conditions. *Prerequisites:* EMIS 3340 and 3360. (Must enroll in lab.)

4(1–4)9(0–4). Undergraduate Project. An opportunity for the advanced undergraduate student to undertake independent investigation, design or development. Variable credit from one to four term hours. Written permission of the supervising faculty member is required before registration. At least 0.5 of (1–4) TCH Design.

4395. Senior Design. A large project involving the design of a management system. Will include model building, data collection and analysis, and evaluation of alternatives. 3 TCH Design. *Prerequisites: C-* or better in EMIS 5362 and senior standing.

5050. Undergraduate Internship Program.

5300. 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.

5301. Systems Engineering Process. The discipline, theory, economics and methodology of systems engineering are 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.

5303. 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.

5305. Systems Reliability, Supportability and Availability Analysis. This course is an introduction to systems reliability, maintainability, supportability and availability (RMS/A) 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 5300 or equivalent.

5307. 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.

5310. Systems Engineering Design. An introduction to system design of complex hardware and software systems. Specific topics include design concept, design characterization, design elements, reviews, verification and validation, threads and incremental design, unknowns, performance, management of design, design metrics, and teams. The class will center on the development of real-world examples.

5315. Systems Architecture Development. A design-based methodological approach to system architecture development using emerging and current enterprise architecture frameworks. Topics include structured analysis and object-oriented analysis and design approaches; enterprise architecture frameworks, including the Zachman framework, FEAF, DoDAF and ANSI/IEEE-1471; executable architecture model approaches as tools for system-level performance evaluation and 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 5301.

5318. Systems Engineering Planning and Management. This course 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 program manager and systems engineer are unveiled for establishing program operations and a 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 proving the design basis. The course leads the student through the systems development process by showing how to plan for and manage change by implementing methods for configuration, change and risk management. The program life cycle is concluded by planning the transition of systems engineering processes from development to production and field support. *Prerequisite:* EMIS 5301.

5320. 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 5301.

5330. Systems Reliability Engineering. An in-depth coverage of tasks, processes, methods and techniques for achieving and maintaining the required level of system reliability considering operational performance, customer satisfaction and affordability. Specific topics include establishing system reliability requirements, reliability program planning, system reliability modeling and analysis, system reliability design guidelines and analysis, system reliability testing and evaluation, and maintaining inherent system reliability during production and operation.

5335. Human-Systems Integration (HSI). 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; and usability testing and assessment) are presented and discussed. *Prerequisite:* EMIS 5301.

5340. Logistics Systems Engineering. An introduction to concepts, methods and techniques for engineering and development of logistics systems associated with product production/manufacturing, product order and service fulfillment, and product/service/customer support, utilizing system engineering principles and analyses. Specific topics include logistics systems requirements, logistics systems design and engineering concurrently with product and service development, transportation and distribution, supply/material support, supply Web design, and management and product/service/customer support.

5347. Critical Infrastructure Protection/Security Systems Engineering. This course presents systems engineering (SE) concepts as applied to the protection of the United States' critical infrastructure (CI). A top-level systems viewpoint provides a greater understanding of this system-of-systems (SOS). Topics include the definitions and advantages of SE practices and fundamentals; system objectives that include the viewpoint of the customer, user and other stakeholders; the elements of the CI and their interdependencies; the impact transportation system disruptions; and systems risk analysis. *Prerequisites:* EMIS 5301 and EMIS 5303.

5351. Enterprise Fundamentals. An overview of business fundamentals, spanning the range of all functional areas: management, marketing, operations, accounting, information systems, finance and legal studies. Credit is not allowed for both EMIS 3308 and EMIS 5351.

5352. Information System 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.

5353. Information System Design Strategies. Surveys the fundamentals of software engineering and database management systems (DBMS) for information engineers. 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.

5357. Decision-Support Systems. Covers the development and implementation of a data-centric, decision-support system (DSS), the underlying technologies, and current applications and trends. Topics include decision-making, DSS components, optimization models, expert systems, data mining and visualization, knowledge discovery and management, and executive information systems. *Prerequisites:* EMIS 5360 and EMIS 3360 recommended but not required.

5359. 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 5360.

5360. 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.

5361. Computer Simulation Techniques. An introduction to the design and analysis of discrete probabilistic systems using simulation. Emphasizes model construction and use of a simulation language. 1.5 TCH Design. *Prerequisites:* Programming ability, and introduction to probability or statistics.

5362. Production Systems Engineering. This course applies the principles of engineering, or "design under constraint," to modern production systems. Topics include production systems analysis and design considerations, systems design and optimization models and methods, pull- and push-based production systems, quality engineering, process improvement, plus techniques for engineering and managing systems with specific architectures: batch-oriented, continuous-flow, project and just-in-time. *Prerequisite: C-* or better in EMIS 3360.

5364 (STAT 5344). Statistical Quality Control. An introduction to statistical quality-control methods that can be applied to meet the demand for ever-increasing levels of product and service quality. Basic methods and tools for analyzing, controlling, and improving product and service quality 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 3340 or 5370.

5365. 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.

5366. Marketing Engineering. Marketing engineering moves beyond traditional conceptual approaches to embrace the use of analytics, data, information technology and decision models to help organizations effectively reach customers and make marketing decisions. Designed for technical individuals, the course applies engineering problem-solving approaches and computer tools to solve marketing problems from today's competitive work environment. *Prerequisites:* EMIS 3340 or 5370, and EMIS 3360 or 8360 (or equivalent).

5369. Reliability Engineering. An introduction to reliability engineering concepts, principles, techniques and methods required for design and development of affordable products and services that meet customer expectations. Topics include reliability concepts and definitions, figures-of-merit, mathematical models, design analysis and trade studies, reliability testing, including types of tests, test planning and analysis of test results, and statistical analysis of reliability data. 1 TCH Design. *Prerequisite: C-* or better in EMIS 3340 or 5370.

5377 (STAT 5377). Statistical Design and Analysis of Experiments. An 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 factorial experiments. Descriptive and inferential statistics. Analysis of variance models. Mean comparisons. *Prerequisites and corequisites: C-* or better in EMIS 3340 or 5370, and senior standing with a science or engineering major, or permission of instructor.

5380. 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.

5382. 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.

5(1–3)9(0–4). Special Topics. Individual or group study of selected topics in management science. *Prerequisite:* Permission of instructor.

MECHANICAL ENGINEERING

Professor Volkan Otugen, **Chair**

Professor Radovan Kovacevic, **Director, Research Center for Advanced Manufacturing**

Professors: Yildirim Hürmüzlü, Radovan Kovacevic, José Lage, Bijan Mohraz, Volkan Otugen, Peter E. Raad, Wei Tong. **Associate Professors:** Paul Krueger, Charles M. Lovas, Edmond Richer, David Willis. **Assistant Professor:** Jeong Ho You. Lecturers: Elena Borzova, Donald C. Price. **Senior Lecturer:** Dona T. Mularkey. **Adjunct Faculty:** Bogdan Antohe, Eric Cluff, Rajeev Dwivedi, Santos Garza, Wade Meaders, David Nowacki, Allen Tilley, Andy Weaver, Jim Webb. ***Emeritus*** **Professors:** Jack P. Holman, David B. Johnson, Paul F. Packman, Cecil H. Smith, Hal Watson, Jr.

Mechanical engineering is a very diverse, dynamic and exciting field. Because of their wide-ranging technical background attained, mechanical engineers have the highest potential for employment after graduation, with exceptional mobility necessary for professional growth even during bear-market conditions. Mechanical engineers apply their creative knowledge to solve critical problems in several different areas, such as bio-engineering (e.g., drug-delivery; artificial organs), 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.

The Mechanical Engineering Department at SMU has a long tradition of offering a superb engineering education within an environment fostering creativity and innovation. Small classes, a trademark of the program, not only provide for strong mentoring but also help achieve academic excellence through cooperation and teamwork. The exceptionally qualified faculty imparts knowledge using the most effective pedagogical skills, assisted in large by the SMU Center for Teaching Excellence and by the Emily C. Norwick Center for Digital Services. Leading by example, through encouragement and dedication, the faculty is committed to the success of every student. In addition to offering the introductory and advanced courses in their areas of specialization, faculty members teach courses that address the critical issues of technology and society, such as courses on machines and society and information technology and society.

The program prepares students to be genuinely 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 the importance of lifelong learning complement the educational experience of students. The department 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 and in the SMU Tau-Sigma Chapter of Pi-Tau-Sigma, the National Honorary Mechanical Engineering Fraternity.

The curriculum consists of three major areas, namely, structures, thermal and fluids, and systems and dynamics and control, interlaced via practical mechanical engineering design throughout the curriculum. In the senior year, student teams are guided through a complete design project, from concept to construction to testing, with support from industries, foundations and volunteer professionals. State-of-the-art software, computers and laboratory equipment support the high-quality education provided to students. Moreover, undergraduate students are encouraged to participate in research projects conducted by faculty and to consider extending their studies toward a graduate degree in mechanical engineering at SMU or elsewhere.

In conjunction with a solid liberal arts component, the program prepares students for graduate studies not only in engineering but also in other professional fields such as business, medicine and law. SMU Mechanical Engineering graduates have consistently and successfully attained higher degrees in engineering, medicine, business and law, besides gaining employment as engineers or consulting engineers for major engineering, pharmaceutical, environmental, financial, banking and real estate companies.

The undergraduate program in mechanical engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700.

The program's mission is to educate mechanical engineers who are innovative, entrepreneurial and equipped to become global leaders in research and technology.

Specific educational objectives of the mechanical engineering undergraduate program are to produce graduates who:

1. Will be innovative problem solvers and critical thinkers addressing technical and societal issues.
2. Will embrace professional development and lifelong learning relevant to their careers.
3. Will have entrepreneurial and leadership roles in industry, government and academia.

The Mechanical Engineering Undergraduate Program Outcomes and their relationships to the discipline-specific criteria are as follows:

a) An ability to apply knowledge of mathematics, science and engineering.
b) An ability to design and conduct experiments, as well as analyze and interpret data.
c) An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d) An ability to function on multidisciplinary teams.
e) An ability to identify, formulate and solve engineering problems.
f) An understanding of professional and ethical responsibility.
g) An ability to communicate effectively.
h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.
i) A recognition of the need for, and an ability to engage in lifelong learning
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

An outstanding cooperative education program is also available for our students. For further information on the SMU Co-op Program, see Cooperative Education at the beginning of the Lyle School of Engineering section.

The Mechanical Engineering Department offers the following degrees:

Bachelor of Science in Mechanical Engineering
Bachelor of Mechanical Engineering with a Bachelor of Science in Math Dual Degree
Bachelor of Mechanical Engineering with a Bachelor of Science in Physics Dual Degree

Bachelor of Science in Mechanical Engineering
(with a Minor in Business Administration)
Bachelor of Science in Mechanical Engineering
(with a Premedical/Biomedical Specialization)
Bachelor of Science in Mechanical Engineering
(with a Manufacturing Specialization)
Bachelor of Science in Mechanical Engineering
(with an Engineering Management and Entrepreneurship Specialization)
Master of Science in Mechanical Engineering
Master of Science in Manufacturing Systems Management
Master of Science in Packaging of Electronic and Optical Devices
Doctor of Philosophy in Mechanical Engineering

In addition, a minor in mechanical engineering is available to interested students.

Departmental Facilities

In support of the teaching and research endeavors of the department, several research laboratories are available.

Laboratory for Porous Materials Applications. This laboratory is concerned with modeling; numerical simulation; and experimental testing of mass, energy and momentum transport in heterogeneous and porous media.

Nano-Scale Electro-Thermal Sciences Laboratory. This facility focuses on non-invasive characterization of the thermal properties of thin-film materials.

Laser Micromachining Laboratory. This laboratory conducts studies of laser-assisted microfabrication, including high-power laser ablation and laser micromachining.

Experimental Fluid Mechanics Laboratory. This facility focuses on pulsed jet micropropulsion and flow-through porous media.

Micro, Nano, and Biomechanics of Materials Laboratory. This 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. This facility 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 or microprocessor interfacing for control and instrumentation.

Micro-Sensor Laboratory. This 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.

Systems Laboratory. This facility is dedicated to analysis and modeling of bipedal gait dynamics, rigid body impact mechanics and the pneumatically operated haptic interface system.

Research Center for Advanced Manufacturing. The RCAM center 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.

Center for Laser-Aided Manufacturing. This facility is housed in the RCAM facility and collaborates with RCAM.

Biomedical Instrumentation and Robotics Laboratory. This laboratory's research activities 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.

Instructional Laboratories

In support of the teaching and research endeavors of the department, several instructional laboratories are available. They include:

Information Technology Computer Laboratory. This laboratory features 25 computer workstations, printers, scanners and an overhead projector with an Internet connection used to support mechanical engineering and non-Lyle School of Engineering undergraduates in meeting the SMU-wide IT requirement for all students.

Computational/Design Laboratory. Dedicated computational facilities that include personal computers and high-resolution color X-terminals, all connected through a high-speed network that allows communication with the school's and University's computers, as well as with off-campus systems via NSFNet. Available Lyle School of Engineering computational facilities include several high-speed, multiprocessor workstations and servers. Educational software includes Parametric Technologies Pro-Engineer CAD system, MATLAB, ANSYS structural analysis package, MacroFlow and Fluent CFD packages.

Graphics Laboratory. Used primarily for first-year graphics, this facility is available for students working on design projects. A special design projects library is located adjacent to the drafting room.

Mechanics of Materials (Structures) Laboratory. This laboratory is equipped for instruction and research on the behavior of materials under various loading conditions such as fatigue, impact, hardness, creep, tension, compression and flexure.

Systems, Measurement and Control Laboratory. This facility 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 is used for microprocessor interfacing for control and instrumentation.

Thermal and Fluids Laboratory. Equipment in this laboratory is used for instruction in experimental heat transfer, thermodynamics and fluid mechanics. Modern equipment is available for conducting experiments on energy conservation; aerodynamics;

internal combustion engines; heating, ventilation and air conditioning systems; convective cooling of electronics; heat exchangers; and interferometric visualization. State-of-the-art systems support automatic control and data acquisition. A partial list of the equipment in this lab includes a refrigeration training unit, heat transfer test unit with water boiler, air flow bench, kinematic viscosity bath, forced convection heat transfer experiment bench, low pressure board, dead weight tester, vortex tube, free and forced heat transfer unit, hydraulic trainer and pneumatic trainer.

Shared Laboratory Space

Laboratories shared with Civil and Environmental Engineering include:

Hydraulics/Hydrology, Thermal and Fluids Laboratory
CAD Computer Laboratory
Structural and Mechanics of Materials Laboratory
Project construction area
Engineering Design Studio

Curriculum in Mechanical Engineering

Mechanical engineering offers the broadest curriculum in engineering to reflect the wide range of mechanical engineering job opportunities in government and industry. The mechanical engineer is concerned with creation, research, design, analysis, production and marketing of devices for providing and using energy and materials. The major concentration areas of the program are:

Solid and Structural Mechanics. Concerned with the behavior of solid bodies under the action of applied forces. The solid body may be a simple mechanical linkage, an aerodynamic control surface, an airplane or space vehicle, or a component of a nuclear reactor. The applied forces may have a variety of origins, such as mechanical, aerodynamic, gravitational, electromotive and magnetic. Solid mechanics provides one element of the complete design process and interacts with all other subjects in the synthesis of a design.

Fluid Mechanics. Deals with the behavior of fluid under the action of forces applied to it. The subject proceeds from a study of basic fundamentals to a variety of applications, such as flow-through compressors, turbines and pumps, around an airplane or missile. Fluid mechanics interacts with solid mechanics in the practice of mechanical engineering because the fluid flow is generally bounded by solid surfaces. Fluid mechanics is also an element in the synthesis of a design.

Thermal Sciences. Concerned with the thermal behavior of all materials – solid, liquid and gaseous. The subject is divided into three important branches, namely, thermodynamics, energy conversion and heat transfer. Thermodynamics is the study of the interaction between a material and its environment when heat and/or work are involved. Energy conversion is a study of the transformation of one form of energy to another, such as the conversion of solar energy to electrical energy in a solar cell. Heat transfer is a study of the processes by which thermal energy is transferred from one body of material to another. Because it takes energy to drive any apparatus and some of the energy always shows up as thermal energy, the thermal sciences interact with all other areas of study and can never be ignored in the design synthesis process.

Materials Science and Engineering. Pertains to the properties of all materials – solid, liquid and gaseous. It deals with mechanical, fluid, thermal, electrical and other properties. Properties of interest include modulus of elasticity, compressibility, viscosity, thermal conductivity, electrical conductivity and many others. The study of materials proceeds from the characteristics of individual atoms of a material, through the cooperative behavior of small groups of atoms, up to the behavior and properties of the bulk material. Because all mechanical equipment is composed of materials, works in a material environment and is controlled by other material devices, it is clear that the materials sciences lie at the heart of the design synthesis process.

Control Systems. Provides necessary background for engineers in the dynamics of systems. In the study of controls, both the transient and steady-state behavior of the system are of interest. The transient behavior is particularly important in the starting and stopping of propulsion systems and in maneuvering flight, whereas the steady-state behavior describes the normal operating state. Some familiar examples of control systems include the flight controls of an airplane or space vehicle and the thermostat on a heating or cooling system.

Design Synthesis. The process by which practical engineering solutions are created to satisfy a need of society in an efficient, economical and practical way. This synthesis process is the culmination of the study of mechanical engineering and deals with all elements of science, mathematics and engineering.

Bachelor of Science in Mechanical Engineering

Curriculum Notes

The minimum requirements for a Bachelor of Science in Mechanical Engineering degree are as follows:

Curriculum Requirements		*Term Credit Hours*
General Education:	ENGL 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics and Sciences:	MATH 1337, 1338, 2339, 2343, 3353 and STAT 4340 or equivalent. PHYS 1303, 1304 and 1105, CHEM 1303; one additional course from the following list: PHYS 3305, 3340, 4321, BIOL 1401, 1402; GEOL 1301, 1305, 1307, 1308, 1313; CHEM 1304; 3000-level or higher math course with the approval of the student's adviser.	31
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381 and 5322.	53
Advanced Major Electives:	Must be selected from 3000-level or higher ME courses with the approval of the student's adviser.	12
Engineering Leadership:	Select two from EMIS 3308, EMIS 3309, CEE 3302 or CSE 4360.	6
Wellness I and II:		2
	Minimum total hours required	**125**

Any deviation from the mechanical engineering curriculum requires approval of a petition submitted by the student to the Mechanical Engineering faculty prior to the beginning of the term during which the student expects to complete the requirements for graduation.

Bachelor of Science in Mechanical Engineering and Bachelor of Science in Mathematics

The Mechanical Engineering Department and the Mathematics Department offer a curriculum that enables a student to obtain both a Bachelor of Science in Mechanical Engineering and Bachelor of Science in mathematics.

Curriculum Notes

The minimum requirements for the dual degree of Bachelor of Science in Mechanical Engineering and Bachelor of Science in mathematics are as follows:

Curriculum Requirements		*Term Credit Hours*
General Education:	ENGL 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics:	MATH 1337, 1338, 2339, 2343, 3315, 3337 and 3353; STAT 4340 or equivalent; CSE 1341; plus one advanced elective as defined in the description of the mathematics major.	30
Sciences:	PHYS 1303, 1304 and 1105; CHEM 1303.	10
Mechanical Engineering:	ME 1202, 1102, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381 and 5322.	50
Advanced Major Electives:	Must be selected from 3000-level or higher ME courses with the approval of the student's adviser.	9
Engineering Leadership:	Select two from EMIS 3308, EMIS 3309, CEE 3302 or CSE 4360	6
Wellness I and II:		2
	Minimum total hours required	**128**

Bachelor of Science in Mechanical Engineering and Bachelor of Science in Physics

The Mechanical Engineering Department and the Physics Department offer a curriculum that enables a student to obtain both a Bachelor of Science in Mechanical Engineering and a Bachelor of Science in physics.

Curriculum Notes

The minimum requirements for the dual degrees of Bachelor of Science in Mechanical Engineering and Bachelor of Science in physics are as follows:

Curriculum Requirements		*Term Credit Hours*
General Education:	ENGL 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics:	MATH 1337, 1338, 2339, 2343, 3353; STAT 4340 or equivalent.	18
Sciences:	PHYS 1105 1303, 1304, 3305, 3344, 3374, 4211, 4321, 4392, 5382, 5383 and two advanced physics electives; CHEM 1303.	39
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381 and 5322.	50
Engineering Leadership:	Select one from EMIS 3308, EMIS 3309, CEE 3302 or CSE 4360.	3
Wellness I and II:		2
	Minimum total hours required	**133**

Any deviation from the mechanical engineering and/or physics curricula requires approval of a petition submitted by the student to the appropriate faculty prior to the beginning of the term during which the student expects to complete the requirements for graduation.

Bachelor of Science in Mechanical Engineering
(With a Minor in Business Administration)

The minimum requirements for a Bachelor of Science in Mechanical Engineering with a minor in business administration are as follows:

Curriculum Requirements		*Term Credit Hours*
General Education:	ENGL 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics and Sciences:	MATH 1337, 1338, 2339, 2343, 3353 and STAT 4340 or equivalent, CHEM 1303, PHYS 1303, 1304, 1105; one additional course from the following list: PHYS 3305, 3340, 4321; BIOL 1401, 1402; GEOL 1301, 1305, 1307, 1308, 1313; CHEM 1304; 3000-level or higher math course with the approval of the student's adviser.	31
Business:	ECO 1312, ACCT 2301, ACCT 2302, FINA 3320, ITOM 3306, MKTG 3340, MNO 3370.	21
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381, 5322.	53
Advanced Major Elective:	Must be selected from 3000-level or higher ME courses with the approval of the student's adviser.	3
Wellness I and II:		2
	Minimum total hours required	**131**

Any deviation from the mechanical engineering curriculum requires approval of a petition submitted by the student to the Mechanical Engineering faculty prior to the beginning of the term during which the student expects to complete the requirements for graduation.

Admission requirements of the Cox School of Business for the Minor in Business Administration program must be satisfied.

Areas of Specialization

Mechanical engineering is a diverse field, and advanced major electives may be selected from a variety of advanced courses in mechanical engineering. In addition, specializations are offered in three important areas, namely, premedical/biomedical, manufacturing, and engineering management and entrepreneurship. Therefore, each student may select one of these three specializations or may personalize his or her degree by particular choices of advanced major electives.

Bachelor of Science in Mechanical Engineering
(Premedical/Biomedical Specialization)

The Mechanical Engineering Department offers a B.S.M.E. degree with a premedical/biomedical specialization. This program enables students to satisfy the premedical or predental requirements for admission to medical or dental school, while at the same time satisfying the requirements for an accredited degree in mechanical engineering.

Curriculum Notes

The minimum requirements for a Bachelor of Science in Mechanical Engineering degree with premedical/biomedical specialization are as follows:

Curriculum Requirements		*Term Credit Hours*
General Education:	ENGL 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics and Sciences:	MATH 1337, 1338, 2339, 2343, 3353 and STAT 4340 or equivalent, BIOL 1401, 1402, 3304, 3350; CHEM 1303, 1113, 1304, 1114, 3371, 3117, 3372, 3118; PHYS 1303, 1304, 1105, 1106.	56
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4370, 4380, 4381 and 5322.	49
Advanced Major Elective:	ME 5332 or any 3000-level or higher ME course.	3
Engineering Leadership:	Select one from EMIS 3308, EMIS 3309, CEE 3302 or CSE 4360.	3
Wellness I and II:		2
	Minimum total hours required	**134**

Bachelor of Science in Mechanical Engineering

(Manufacturing Specialization)

This specialization enables students to select four major electives related to manufacturing engineering and manufacturing systems management. For details of the program, the student should consult the department.

Curriculum Notes

The minimum requirements for a Bachelor of Science in Mechanical Engineering degree with manufacturing specialization are as follows:

Curriculum Requirements		*Term Credit Hours*
General Education:	ENGL 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics and Sciences:	MATH 1337, 1338, 2339, 2343, 3353, and STAT 4340 or equivalent. PHYS 1303, 1304, 1105; CHEM 1303; one additional course from the following list: PHYS 3305, 3340, 4321; BIOL 1401, 1402; GEOL 1301, 1305, 1307, 1308, 1313; and CHEM 1304; 3000-level or higher math course with the approval of the student's adviser.	31
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381 and 5322.	53
Manufacturing Electives:	Manufacturing electives must be approved by the student's adviser and must be selected from the following list: ME 5350, 5351, 5355, 5356, 5357, 5358, 5368, 5372 and 5391.	12
Engineering Leadership:	Select two from EMIS 3308, EMIS 3309, CEE 3302 or CSE 4360.	6
Wellness I and II:		2
	Minimum total hours required	**125**

Any deviation from the mechanical engineering curriculum requires approval of a petition submitted by the student to the Mechanical Engineering faculty prior to the beginning of the term during which the student expects to complete the requirements for graduation.

Bachelor of Science in Mechanical Engineering
(Engineering Management and Entrepreneurship Specialization)

The Mechanical Engineering Department offers a B.S.M.E. degree with an engineering management and entrepreneurship specialization. This program includes required courses in engineering management, information engineering and global perspectives, technical entrepreneurship, and technical communications, while at the same time satisfying the requirements for an accredited degree in mechanical engineering.

Curriculum Notes

The minimum requirements for a Bachelor of Science in Mechanical Engineering degree with a management and entrepreneurship specialization are as follows:

Curriculum Requirements		*Term Credit Hours*
General Education:	ENGL 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics and Sciences:	MATH 1337, 1338, 2339, 2343, 3353, and STAT 4340 equivalent. PHYS 1303, 1304, 1105; CHEM 1303; one additional course from the following list: PHYS 3305, 3340, 4321; BIOL 1401, 1402; GEOL 1301, 1305, 1307, 1308, 1313; and CHEM 1304; 3000-level or higher math course with the approval of the student's adviser.	31
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381 and 5322.	53
Specialization:	EMIS 3308, EMIS 3309, CSE 4360 and CEE 3302.	12
Advanced Major Electives:	Must be selected from 3000-level or higher ME courses with the approval of the student's adviser.	6
Wellness I and II:		2
	Minimum total hours required	**125**

Any deviation from the mechanical engineering curriculum requires approval of a petition submitted by the student to the Mechanical Engineering faculty prior to the beginning of the term during which the student expects to complete the requirements for graduation.

Minor in Mechanical Engineering

For approval of a minor in mechanical engineering, the student should consult the department. A total of 15 term hours in mechanical engineering courses is required. For example, a choice of five of the following courses represents a minor that provides a broad introduction to mechanical engineering.

ME 1202 and **1102** Introduction to Engineering
ME 2310 Statics
ME 2320 Dynamics
ME 2331 Thermodynamics
ME 2340 Mechanics of Deformable Bodies

ME 2342 Fluid Mechanics
ME 3340 Engineering Materials
ME 3370 Manufacturing Processes

Based on the student's interests and background, other sets of mechanical engineering courses may be substituted with the approval of the department.

The Courses (ME)

1102. Introduction to Engineering Lab. Companion laboratory to ME 1202. Introduction to machine shop operations; mechanical measurements; basic research skills; and the design process, including group projects. *Corequisite:* ME 1202.

1202. Introduction to Engineering. Introduction to mechanical engineering and the engineering profession, the design process, sketching, forces in structures and fluids, conservation laws and thermal systems, and the motion of machinery. *Corequisite:* ME 1102.

1301. Machines and Society. This course introduces mechanical engineering to non-engineering students. It covers the basic topics of mechanical engineering, the science and physics behind them, and how they are applied to the machines that create and support today's modern lifestyle. The lab provides a hands-on experience.

1303. Energy, Technology and the Environment. An elementary introduction to how energy is produced and distributed, energy resources, electrical power, heating and cooling, solar energy applications, and other topics related to people and the environment.

1305. Information Technology and Society. A comprehensive survey of information technologies and the growing interconnectivity between them as currently utilized throughout society. Students will acquire portable IT skills in the use of word processing, spreadsheets, presentation tools, graphics applications and the Internet that will prepare them for success in the workplace and beyond. Issues surrounding IT will be discussed, including history, ethics, legal questions, use in producing and maintaining a competitive advantage, effects on society, and associated costs and benefits.

2131. Thermodynamics Laboratory. One three-hour laboratory session per week. Basic thermal-property and power-device measurements to complement lecture material of ME 2331. *Prerequisite* or *corequisite:* ME 2331.

2140. Mechanics of Materials Laboratory. Experiments in mechanics of deformable bodies to complement ME 2340. Simple tension and compression tests on structural materials, simple shear tests on riveted joints, stress and strain measurements, engineering and true stress, engineering and true strain, torsion testing of cylinders, bending of simple supported beams, deflection of simply supported beams, buckling of columns, strain measurements of pressure vessels, Charpy impact tests, and the effect of stress concentrators. *Corequisite:* ME 2340.

2142. Fluid Mechanics Laboratory. One three-hour laboratory session per week. Experiments in fluid friction, Bernoulli's equation, pumps, boundary layers and fluid dynamic drag to complement the lecture material of ME 2342. *Corequisite:* ME 2342.

2310. Statics. Equilibrium of force systems, computations of reactions and internal forces, determinations of centroids and moments of inertia, and introduction to vector mechanics. *Prerequisite:* MATH 1337 or equivalent.

2320. Dynamics. Introduction to kinematics and dynamics of particles and rigid bodies. Newton's laws, kinetic and potential energy, linear and angular momentum, work, impulse, and inertia properties. *Prerequisite:* ME 2310 or equivalent.

2331. Thermodynamics. The first and second laws of thermodynamics and thermodynamic properties of ideal gases, pure substances and gaseous mixtures are applied to power production and refrigeration cycles. *Prerequisites:* MATH 2339, CHEM 1303, ME 2310.

2340. Mechanics of Deformable Bodies. Introduction to analysis of deformable bodies including stress, strain, stress-strain relations, torsion, beam bending and shearing stresses, stress transformations, beam deflections, statically indeterminate problems, energy methods, and column buckling. *Prerequisite:* ME 2310.

2342. Fluid Mechanics. Fluid statics, fluid kinematics, control volumes and applications, irrotational flow, Bernoulli's and Euler's equations, similitude and dimensional analysis, differential analysis of fluid flow, incompressible viscous flow, and boundary layer theory. *Prerequisites:* ME 2310, MATH 2339, PHYS 1303. *Corequisite:* MATH 2343. ME 2320 is recommended, but not required.

3132. Heat Transfer Laboratory. One three-hour laboratory session per week. Experiments in conduction, convection and radiation to complement lecture material of ME 3332 Heat and Mass Transfer. *Prerequisite* or *corequisite:* ME 3332.

3332. Heat and Mass Transfer. Fundamental principles of heat transmission by conduction, convection and radiation; mass transfer; and application of these principles to the solution of engineering problems. *Prerequisites:* ME 2331, 2342.

3340. Engineering Materials. A study of the fundamental factors influencing the structure and properties of structural materials, including metals, polymers and ceramic. Phase diagrams, heat treatment, metallography, mechanical behavior, atomic bonding and corrosion are covered. *Prerequisite:* CHEM 1303 or equivalent.

3341. Intermediate Thermal Sciences. Application of the laws of thermodynamics, availability, irreversibility, real gases and mixtures, generalized thermodynamics relations and charts, and chemical equilibrium. *Prerequisite:* ME 2331.

3350. Structural Analysis. Emphasis on the classical methods of analysis of statically determinate and indeterminate structural systems. Computation of reactions, shears, moments, and deflections of beams, trusses and frames. Use of computers as an analytical tool. *Prerequisites:* ME 2140, 2340.

3360. Fluid Power Systems. Principles of operations, design criteria, and performance characteristics of fluid power systems components such as pumps, motors, valves and cylinders. Goals-oriented circuit design and analysis, industrial standards, circuit representation, and maintenance. Practical/demo lectures, a design project based on specialized software, industry speakers and site visits. *Prerequisites:* ME 2320, 2342.

3370. Manufacturing Processes. This course presents a comprehensive, balanced and up-to-date coverage of the relevant fundamentals and real-world applications of manufacturing processes (casting, forming, machining, high-power laser beam materials processing, electrical discharge machining, abrasive waterjet machining, etc.). Rapid prototyping and manufacturing are included in the course as well. A set of laboratories is designed to introduce students to manufacturing processes and to reinforce the lecture material. *Prerequisite:* ME 3340.

3390 (CFA 3390). German Technoculture. Fundamentals of German contemporary culture within the context of technology and study abroad experience. Emphasis is placed on communication skills. Field trips are an integral part of the course.

4090. Senior Project.

4160. Control Laboratory. Experiments in control engineering. Digital and analog simulation of feedback control systems. Actuator saturation. Design and implementation of simple control systems on various laboratory equipment. *Prerequisite* or *corequisite:* ME 4360.

4338. Thermal Systems Design. Thermal systems designs are prepared, presented and critiqued. Associated problems of simulation, optimization and economics are solved. Solving problems and design with a thermal network analyzer are included. 3 TCH Design. *Prerequisite:* ME 3332.

4350. Design of Steel Structures. Study of strength, behavior and design of steel structures and reinforced concrete structures members subjected to flexure, shear and axial loads. *Prerequisite:* ME 3350.

4351. Ethical Decision-Making in Applied Science and Engineering Technology. Ethical issues, hard choices and human failures in notorious, historical cases such as the Space Shuttle Challenger, Grand Teton Dam and Union Carbide-Bhopal disasters. Principles, methods and bases for ethical decision-making and action. Application of classical ethical philosophy to hypothetical, modern problems and dilemmas in the business of control and implementation of technology.

4360. Design and Control of Mechanical Systems. Block modeling of mechanical systems. Mathematical models of linear systems. Solution of differential equations by use of Laplace transforms. Feedback control systems; time domain analysis; stability; frequency response; and root locus plots, Bode diagrams, performance criteria and system compensation. Design of control systems for mechanical systems. *Prerequisite:* ME 5322 or equivalent.

4370. Elements of Mechanical Design. Application of the principles of mechanics and physical properties of materials to the proportioning of machine elements, including consideration of fatigue, functioning, productivity and economic factors. Computer applications. 3 TCH Design. *Prerequisites:* ME 2340, 3370.

4380. Mechanical Engineering Design I. A study of design methodology and development of professional project-oriented skills including communication, team management, creative problem solving, interpersonal management and leadership skills. Team-project activities are used to apply project-oriented skills to solution of design problems. Nontechnical considerations in design, including patents, ethics, aesthetics, safety and economics are investigated. 3 TCH Design. *Prerequisite* or *corequisite:* ME 3370 or senior standing.

4381. Mechanical Engineering Design II. Student design teams have full responsibility for conducting a full-term design project for an industrial client. Periodic design reports and design reviews are presented to, and critiqued by, the industrial client, the faculty and the design team. 3 TCH Design. *Corequisite:* ME 4370. *Prerequisite:* ME 4380.

5050. Undergraduate Internship. Component: internship.

5302 (EE 5362). Linear Systems 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 include state representation of linear systems, controllability, observability, minimal representation, linear state variable feedback, observers and quadratic regulator theory. *Prerequisite:* ME 4360 or instructor approval.

5314. Introduction to Microelectromechanical Systems (MEMS) and Devices. This course develops the basics for microelectromechanical devices and systems (including microactuators, microsensors and micromotors). Other topics include principles of operation, different micromachining techniques (surface and bulk micromachining), IC-derived microfabrication techniques and thin-film technologies as they apply to MEMS.

5319. Advanced Mechanical Behavior of Materials. A senior-graduate course that relates mechanical behavior on a macro- and microscopic level to design. Topics include macroscopic elasticity and plasticity, viscoelasticity, yielding, yield surfaces, work hardening, geometric dislocation theory, creep, and temperature-dependent and environment-dependent mechanical properties *Prerequisites:* ME 2340, 3340.

5320. Intermediate Dynamics. The emphasis of this course is on methods of formulation and solution of the kinematical, dynamical and motion constraint equations for three dimensional, lumped-parameter, dynamical systems. Differentiation of vectors, kinematics, inertia properties, momentum and energy principles, generalized forces, holonomic and nonholonomic constraints, constrained generalized coordinates, and Newton-Euler and Lagrange formulations of the equations of motion will be discussed in detail. The symbolic software Mathematica will be used to reduce the time and effort required to derive the kinematical and dynamical equations. Practical examples of detailed motion analysis of mechanisms using CAD software augment the theoretical formulations. *Prerequisites:* ME 2320, MATH 2339, 2343.

5321. Failure Analysis. 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, and causes of failure. *Prerequisite:* ME 3340.

5322. Vibrations. Review of fundamentals of vibrations with application of simple machine and structural members. Topics include harmonic motion, free and forced vibration, resonance, damping, isolation, and transmissibility. Single, multiple and infinite degree-of-freedom systems are also examined. *Prerequisites:* ME 2320, and MATH 2343 or equivalent.

5323. Introduction to Fracture Mechanics. This course focuses on linear elastic fracture mechanics; application of theory to design; and evaluation of critical components, including 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.

5324. Fatigue Theory and Design. A senior-graduate course that includes continuum, statistical and fracture mechanics treatments of fatigue, stress concentrators, planning and analysis of probit, SNP and response tests, mechanisms of fatigue design, fail safe vs. safe life design, and crack propagation. Emphasizes engineering design aspects of fatigue rather than theoretical mechanisms. *Prerequisite:* ME 3340.

5326. 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 and 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.

5330. Heat Transfer. Application of the principles of conduction, convection and radiation heat transfer. Topics include steady and unsteady state, special configurations, numerical and analytical solutions, and design. *Prerequisite:* ME 3332 or equivalent.

5331. Advanced Thermodynamics. This course examines the laws of thermodynamics, availability, irreversibility, real gases and mixtures, thermodynamic relations and generalized charts, combustion, chemical and phase equilibrium, and computational combustion. *Prerequisite:* ME 2331.

5332. Heat Transfer in Biomedical Sciences. Review of the fundamentals of heat transfer in medicine and biology, including biothermal properties and thermal regulation processes. Topics include biomedical heat transfer processes with applications in tissue laser radiation, freezing and thawing of biological materials, cryosurgery and others. *Prerequisites:* ME 2342, 3332 or consent of instructor.

5333. Transport Phenomena in Porous Media. This course examines fractals and their role in characterizing complex structures. Fundamental concepts of momentum, heat and mass transport through heterogeneous (e.g., composites, porous) materials are reviewed. 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 consent of instructor.

5334. Fundamentals of Electronic Packaging. This course covers: introduction to microsystems packaging, role of packaging in microelectronics, role of packaging in microsystems, electrical package design, design for reliability, thermal management, single- 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.

5335. 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:* ME 3332.

5337. Introduction to Computational Fluid Dynamics: Fundamentals of Finite Difference Methods. This course explores concepts of stability, convergence, accuracy and consistency. Includes applications to linear and nonlinear model partial differential equations. Other topics include curvilinear grid generation, Beam and Warming factored implicit technique, and MacCormack techniques. Solution methods for the Reynolds equation of lubrication, the boundary layer equations and the Navier-Stokes equations are also reviewed. *Prerequisites:* ME 2342 (or equivalent), MATH 2343 (or equivalent), or consent of instructor.

5340. Introduction to Solid Mechanics. Introduction to three-dimensional stress and strain, failure theories, two-dimensional elasticity, torsion of prismatic members, beams on elastic foundation, plates and shells, and energy methods. *Prerequisites:* ME 2340, MATH 2343.

5341. Structural Properties of Solids. Designed to develop an understanding of the structural aspect 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 consent of instructor.

5342. Introduction to Thermal Management of Electronics. Introduction to thermal and mechanical design of electronic packaging to include fundamentals of fluid flow, heat transfer, modern cooling technologies and thermal management. Covers mechanical designs, including stress and vibrations covered through industrial applications. Other topics include coupled thermal and mechanical problems systems, including selection of cooling methods and hardware important to good design. Classical methods are used to design equipment that operates in severe vibration environments. *Prerequisite:* ME 3332.

5343. Electronic Packaging Materials: Processes, Properties and Testing. Provides an overview of materials for electronic packaging. Examines solderability, microscopic processes and alloy selection. Looks at composites and ways to apply conducting polymer-matrix composites, metal films and vacuum processes. The importance of encapsulation, temperature humidity bias testing and temperature cycle testing will be covered. Measurement of properties of materials in electronic packaging, thermal properties, physical properties and manufacturing properties and materials selection will also be covered.

5344. 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 (TIMS); phase change materials (PCMs); thermoelectric devices; Stirling cycle refrigerators; and the cooling of special electronic components such as multichip modules, power modules, high-density power supplies and printed wiring boards. The thermal management by conduction of GaAs and GaN MMICs (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:* ME 3332.

5346. Application of Computational Techniques to the Mechanical and Thermal Design of Electronic Systems. This course will develop the student's capability to characterize the mechanical and thermal performance of electronic devices and systems through the use of computational techniques. Commercial codes will be used to create a thermal model of a fan-cooled, rectangular geometry, electronics chassis, using direct air-cooling. Additional computer codes for thermal modeling of heat transfer and fluid flow systems will be featured. In addition, codes for the design of cold plates and heat exchangers will be utilized. The student will be exposed to concepts of structural modeling of components mounted on printed wiring boards in a vibration environment. A number of industry-related problems, ranging from first-level packages, printed wiring boards, and system-level electronics will be analyzed. At the end of the class, a student will be expected to formulate and model a complex industry-based problem. *Prerequisites:* ME 2320, 2340, 3332, 3350.

5348. 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. *Prerequisites:* ME 2342, 2142, 2340, 2140, 3332, 3132.

5357. Optimized Mechanical Design. Examines principles and methods for optimal design of machine elements (springs, shafts, gears, weldments of joints, etc.) and mechanical systems (transmissions, cam systems, inertia loads and balancing, etc.). Includes computer applications. *Prerequisite:* ME 4370 or equivalent.

5358. Design of Electronic Packaging. This course focuses on thermal and mechanical design of electronic packaging. Fundamentals of heat transfer and fluid flow are applied to electronic packages and systems, including selection of fans, heat sinks and other hardware important to good design. Mechanical designs of equipment that operates in more severe shock and vibration environments are developed using classical methods, with consideration given to selecting appropriate hardware. *Prerequisites:* ME 2320, MATH 2343, 3339.

5359. Analysis and Design of Optoelectronic Packaging. Provides an overview of optical fiber interconnections in telephone networks, packaging for high-density optical back planes, selection of fiber technologies; semiconductor laser and optical amplifier packaging, optical characteristics and requirements, electrical properties, mechanical properties, waveguide technologies, optical alignment and packaging approaches, passive device fabrication and packaging, array device packaging; hybrid technology for optoelectronic packaging, and flip-chip assembly for smart pixel arrays.

5360. Electronic Product Design and Reliability. Provides a complete description of the fundamentals of the design process for electronic products. Covers the obtaining of the voice of the customer through processes such as quality function deployment. Analyzes the process of conceptual design. Carries the concept through the parametric and tolerance analysis. The design review process will be discussed as well as a review of the use of CAD tools for schematic capture and PWB layout. Reviews the use of modern tools for the maintenance of design documentation, the process of product realization through prototypes, manufacturing trials and the introduction into high volume manufacturing. The impact of design choices on product quality and reliability will be discussed in detail as will the prediction and measurement of product lifetimes. *Prerequisite:* ME 3340.

5361. Matrix Structural Analysis and Introduction to Finite Element Methods. A systematic approach to formulation of force and displacement method of analysis. Includes representation of structures as assemblages of elements and computer solution of structural systems. *Prerequisite:* ME 3350 or equivalent.

5362. Engineering Analysis With Numerical Methods. Application of numerical and approximate methods in solving a variety of engineering problems. Examples include equilibrium, buckling, vibration, fluid mechanics, thermal science and surveying problems. *Prerequisite:* Senior standing.

5363. Electronic Manufacturing Technology. Covers the complete field of electronics manufacturing. Topics include an introduction to the electronics industry, electronic components, the theory and methods of manufacture of solid state devices, packaging techniques such as wire bonding flip chip and TAB, printed wiring board, soldering and solderability, leaded and surface-mounted components, electromagnetic interference, electrostatic discharge prevention, testability, and electronic stress screening. In each area, the current technology, as well as leading-edge tools, are discussed.

5364. Introduction to Structural Dynamics. Introduction to dynamic responses of structures and behavior of structural components to dynamic loads and foundation excitations. Examines single- and multi-degree-of-freedom systems response and its applications to analysis of framed structures. Includes introduction to systems with distributed mass and flexibility. *Prerequisite:* MATH 2343.

5371. Introduction to Gas Dynamics and Analysis of Propulsion Systems. Introduction to the mechanics and thermodynamics of high-speed compressible flows with application to the design of propulsion systems. Focus is on one-dimensional and quasi one-dimensional compressible flow, normal shocks, oblique shocks, and two-dimensional flow method of characteristics. Also includes analysis of air-breathing propulsion systems and design of air-breathing propulsion systems components such as inlets and nozzles. *Prerequisites:* ME 2342, 2331.

5372. Introduction to CAD. Introduction to mechanical computer-aided design. Survey of technical topics related to computer-aided design and computer-aided manufacturing. Emphasis on the use of interactive computer graphics in modeling, drafting, assembly and analysis. Extensive hands-on use of a state-of-the-art CAD system. *Prerequisite:* Junior standing or consent of instructor.

5376. Robotics: Introduction to Computer-Aided Manufacturing. Introduction to industrial robotics and numerically controlled machines. Topics include economics of CAM applications or robotics in industry, robot safety, addition of senses and intelligence, and research in CAM flexible manufacturing cells and systems. Hands-on laboratory work with industrial robots and numerical control machines. Independent study and report on a specific robot application. *Prerequisites:* CSE 1341, PHYS 1403, and MATH 2343 or equivalent.

5383. Heating, Ventilating and Air Conditioning. Focuses on selection and design of basic refrigeration, air conditioning and heating systems. Load calculations, psychometrics, cooling coils, cooling towers, cryogenics, solar energy applications and special topics are included. *Prerequisites:* ME 2331, 3332.

5(1–4)90. Undergraduate Seminar. Provides an opportunity for the advanced undergraduate student to undertake independent investigation, design and development. The project, and the supervising faculty, must be approved by the chair of the department in which the student expects to receive the degree. Variable credit of one to four term hours.

5(1–4)9(1–5). Special Projects. Intensive study of a particular subject or design project not available in regular course offerings and under the supervision of a faculty member approved by the department chair. Variable credit of one to four term hours.

CENTER FOR SPECIAL STUDIES

The Special Studies designation is used to accommodate academic programs and courses that do not typically fit within the departments of the Lyle School of Engineering. Included under this section are courses designed for Engineering Cooperative Education Program students and first-year students exploring engineering degree programs.

The Courses (SS)

1099, 2099, 3099, 4099, 5099. Engineering Co-op Workterm. Each of these courses represents a term of industrial work activity in connection with the Engineering Cooperative Program. The courses are taken in numerical sequence and carry no credit. Students register for these courses in the same manner as for other SMU courses except that no tuition is charged. Each course grade is determined from the grading of the student's written report and from the scoring of the employer's and student's evaluation forms.

1101. Engineering and Beyond. This one-hour course is designed to assist first-year students in making an informed decision about their choice of major. Students experience each engineering department and the degrees offered through real-world examples of engineering.

5(0–4)9(0–4). Special Topics. Individual or group study of selected topics in applied science. These are areas that do not belong strictly to any department, but nevertheless are meaningful to the Lyle School of Engineering. *Prerequisite:* Permission of instructor.

RESERVE OFFICERS' TRAINING CORPS

Army ROTC. Army ROTC courses are not offered on the SMU campus. Students can participate in the Army ROTC program at the University of Texas at Arlington by enrolling as they enroll for other SMU courses. Further program information and application procedures may be obtained by contacting the UTA Department of Military Science at 817-272-3281. Students who participate in the UTA Army ROTC program are responsible for their own travel and other physical arrangements.

Army ROTC offers students the opportunity to graduate as officers and serve in the U.S. Army, the Army National Guard or the U.S. Army Reserve. Army ROTC scholarships are awarded on a competitive basis. Each scholarship pays for tuition and required educational fees and provides a specified amount for textbooks, supplies and equipment. Each scholarship also includes a subsistence allowance of up to $1,000 for every year the scholarship is in effect.

Students can enroll in the Army ROTC on-campus program as they enroll for other SMU courses. Army ROTC courses are listed under ROTC in the Access.SMU schedule of classes, and permission to enroll must be obtained from Karen Coleman at kcoleman@engr.smu.edu or 214-768-3039.