SCHOOL OF ENGINEERING AND APPLIED SCIENCE

GENERAL INFORMATION

THE SCHOOL OF ENGINEERING AND APPLIED SCIENCE

The School of Engineering and Applied Science (SEAS) 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, SEAS began one of the first cooperative education programs in the United States, a program that continues to put engineering students to work on real technical projects today.

Included in the SEAS curricula are programs in electrical engineering, environmental engineering, environmental science, computer engineering, computer science, management science, mechanical engineering, and telecommunications systems. And 1990 was the kickoff year for the Complete Engineer — a renewed emphasis on a well-rounded humanities and social sciences education combined with technical specialization. This emphasis continues today.

Corporate support for the engineering school has generated a remarkable array of equipment and laboratories. Recent additions include a microwave lab from General Dynamics, a robotics lab from General Electric, and an undergraduate circuit lab from Southwestern Bell. Other laboratories are in development, including one sponsored by AT&T. The Dallas area's national prominence in high technology and research has been a major plus for SEAS.

SEAS is a founder and charter member of the Association for Media-based Continuing Education for Engineers (AMCEE), a nationwide consortium of engineering schools that offer videotaped continuing education courses. In addition, the school is a founding member of the National Technological University (NTU), which offers engineering education to students across the country via direct broadcast satellite relay. SEAS is one of only 44 engineering schools in the United States to participate.

PROFESSIONAL ENGINEERING REGISTRATION

All senior-year engineering students are encouraged to take the first part of the examination for professional engineering registration in the state of Texas. This is known as the *Fundamentals of Engineering Examination* and is given twice each year, in early April and early October. Application forms for the examination may be obtained from the Office of the Dean.

PROGRAM INFORMATION

All programs of education and research in engineering and applied science are conducted through SEAS. The school is organized into the following three departments:

Computer Science and Engineering (CSE)
Electrical Engineering (EE)
Mechanical Engineering (ME)

SEAS offers curricula leading to the Bachelor of Science degree in the following programs (the department responsible for each program is indicated in parentheses):

Computer Engineering (CSE)
Computer Science (CSE)
Electrical Engineering (EE)
Environmental Engineering (EnvE)
Environmental Science (EnvS)
Management Science (CSE)
Mechanical Engineering (ME)
Telecommunications Systems (EE)

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

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

The departments are SEAS' 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, videotaped courses, and television courses offered through The Association of Graduate Education and Research (TAGER).

More information on SEAS and its programs is available on the World Wide Web at www.seas.smu.edu.

COOPERATIVE EDUCATION

The history of the School of Engineering and Applied Science at SMU demonstrates a commitment to the concept of cooperative education. When SEAS 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 (Co-op) 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 SEAS undergraduate students participated in Co-op. Since 1965, the program has been optional.

In 1999, SMU became one of the first universities to receive accreditation from the newly formed Accreditation Council for Cooperative Education (ACCE). The SMU program is one of eight professional work-based university programs to receive ACCE accreditation, and the only Texas university to earn this distinction.

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. Today, approximately one-third of SEAS students choose to participate. Participation in the Co-op 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 starting salary before graduation.
- Gain invaluable work experience when competing for full-time jobs upon graduation.

HOW THE COOPERATIVE PROGRAM OPERATES

Entry into the Co-op Program typically is offered at either of two times during the student's academic progression. These are shown below:

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

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

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

Each applicant receives quality advising from the Co-op 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 Cooperative Education Training Employment beginning in the spring term during the sophomore year.

Who May Apply?

Any SEAS 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 SMU Co-op 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 Greek Rush during the second term of their first year.
- 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, SMU SEAS has created and maintained numerous strong corporate relationships. Many factors contribute to these relationships, including the quality of the academics and research, the advancement of alumni, and SMU's close proximity to high-tech corporations. An SMU Co-op student directly benefits from these relationships.

However, the student bears an obligation to preserve these relationships for future students by following SMU's SEAS Co-op Program Undergraduate Student Agreement. The agreement balances the student's individual needs with the long-term goal of maintaining corporate relationships so that future SMU students will have as many opportunities as possible.

- Students must maintain good standing with SMU and their employer at all times.
- All Co-op Training Jobs must be approved in advance by the SMU Co-op Director.
- Before each work term begins, each undergraduate Co-op student must enroll in the appropriate Co-op 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 Co-op Director. The courses do not count toward graduation. The course numbers for each work term are, respectively, SS 1099, SS 2099, SS 3099, SS 4099, SS 5099, and SS 6099.
- Students enroll at SMU each term, including summers, once they begin the Co-op alteration 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 Co-op employer during school terms.
- Co-op students complete all work terms with the same company.
- Once a student accepts a Co-op Training Job, the student may switch jobs within the sponsoring company with the approval of the company.
- Each Co-op student completes their originally planned number and sequence of alternating work terms. The term of graduation must be a term of full-time study at SMU.
- Each Co-op student accepts responsibility for knowing and following all Co-op Regulations of SMU and the participating employer.

Co-op Certificate

Co-op students who plan and complete all originally scheduled co-op work terms in good standing with the university and the Co-op Office receive a Co-op Program Certificate to coincide with graduation.

Contact the Co-op Director at 214-768-3033 or by e-mail at coop@seas.smu.edu if you have additional questions. If you visit campus, the Co-op Office is in the School of Engineering and Applied Science in room 106 of Caruth Hall.

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 and applied science apply for undergraduate admission to SMU as first-year or transfer students through the Office of Admission, Southern Methodist University, PO Box 750181, Dallas TX 75275-0181. The application deadline for entry into a fall term by a first-year student is April 1, and for a spring term, December 1. For transfer students, the application deadline is July 1 for a fall term and December 1 for a spring term.

All first-year applicants admitted to SMU initially enter Dedman College. To be considered for admission, a student must have graduated from an accredited secondary school and must submit the following information to the Office of Admission:

1. An official high-school transcript for grades 9-12, showing rank in class, G.P.A., and senior courses.
2. Results of the SAT or ACT. For foreign students, the result of the TOEFL is required as well.
3. Counselor recommendation.
4. Extracurricular activities.

A personal interview with the Office of Admission and the Assistant Dean of the School of Engineering and Applied Science is highly recommended.

HIGH SCHOOL PREPARATION

Because of the high standards of the School of Engineering and Applied Science 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 and Applied Science 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 our most competitive applicants. To be successful in our 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. Have a minimum SAT composite of 1100 with at least a 600 math score. Equivalent ACT scores 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, admission to the School of Engineering and Applied Science is accomplished by an interschool transfer. These transfers are approved by the Assistant Dean of Undergraduate Studies. 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 2.00 or higher G.P.A. For admission into either the computer engineering, electrical engineering, environmental engineering, or mechanical engineering program, a 2.00 or higher G.P.A. is required in the following five courses: ENGL 1301, ENGL 1302 or equivalent, MATH 1337, MATH 1338, and PHYS 1303. If a course is repeated, both grades will be used in computing the G.P.A.

Admission by Transfer from Another Institution

An undergraduate at a junior college, college, or university may apply for admission to the School of Engineering and Applied Science. Admission will be granted provided the prior academic records and reasons for transfer are acceptable to SEAS. Transfer credit will be awarded in courses that have identifiable counterparts in curricula of the School of Engineering and Applied Science, 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 are regionally accredited. Because of SMU's 60-term-hour residency requirement for a Bachelor's degree, there is a limit on the total amount of credit that may be transferred from four-year institutions.

ACADEMIC REGULATIONS

GRADUATION REQUIREMENTS FOR BACCALAUREATE DEGREES

Graduation from the School of Engineering and Applied Science 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 G.P.A. of 2.00 or better must be attained in all college and university courses.
3. An overall G.P.A. of 2.00 or better must be attained in all course work attempted at SMU for the degree.
4. An overall G.P.A. of 2.00 or better must be attained in all course work attempted for the degree in the major field of study.
5. A minimum of 122 term hours of credit, including 35-41 hours in the General Education Curriculum and the requirements for a major in engineering or applied science.

Residence Requirements

For graduation from the School of Engineering and Applied Science, 60 term credit hours must be earned in residence, 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 in residence. Exceptions to this requirement will be made only under unusual circumstances at the discretion of the SEAS faculty.

The Major

A candidate for a degree must complete the requirements for a major in one of the departments of SEAS. 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 in which the major is declared, or those of a subsequent academic year. Course work counting toward a major may not be taken pass/fail. Majors must be officially declared (or changed) through the office of the Assistant Dean 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 so that each student learns to reason and think for oneself; becomes skilled in communicating meaning and in understanding it; understands something about both the social and the natural worlds and one's own place and responsibilities in them; and understands and appreciates human culture and history in their various forms, including religion, philosophy, and the arts.

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

PROGRAMS OF STUDY

The School of Engineering and Applied Science offers the following degrees:

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

Engineering and applied science 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 and applied science 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 curricula in computer engineering, electrical engineering, and mechanical engineering are accredited by the Accreditation Board for Engineering and Technology (ABET).

JUNIOR YEAR ABROAD

Many undergraduates in American universities have found it academically and culturally rewarding to spend their junior year at a university in another country. This opportunity has rarely been used by students concentrating in programs in engineering and applied science because of the integrated nature of curricula in these fields. However, as a result of arrangements with several of the Colleges in the University of London in England, it is now possible for undergraduates in SEAS to undertake their junior year as students at the University of London without delaying their progress toward a baccalaureate degree.

To be eligible for this program, students should normally have attained a G.P.A. of at least 3.00 and also have the academic and social maturity needed to adapt to the different academic and social customs in English universities. For detailed information about this program, students should consult their academic advisers and the undergraduate dean in SEAS early in their sophomore year.

DESCRIPTION OF COURSES

Courses offered in the School of Engineering and Applied Science are identified by a two- or three-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 4322 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 22. The prefix codes are as follows:

CSE — Department of Computer Science and Engineering
EE — Department of Electrical Engineering
ENV — Department of Environmental Engineering
ME — Department of Mechanical Engineering
SS — Center for Special Studies

COMPUTER SCIENCE AND ENGINEERING

Associate Professor Helgason, *Interim Chair*

Professors: Kennington, Matula, Moldovan; *Associate Professors:* Barr, W. Chen, J. Dunham, M. Dunham, Nair; *Assistant Professors:* Harabagiu, Olinick, Seidel, Tian; *Lecturers:* Coyle, D. Evans, Lillard; *Adjunct Faculty:* Bralick, Diaz, Frailey, Oshana, Petersen, Pfister, Pickels, Schmidt, Siems.

The department offers academic programs in *computer engineering* (with an emphasis on computer design), *computer science* (with an emphasis on systems design), and *management science* (with an emphasis on computer models for decision making). Faculty specializations include computer architecture, knowledge engineering, software engineering, design and analysis of algorithms, parallel processing, database and information systems, artificial intelligence, theory of computation, graph and network algorithms, and mathematical programming.

DEGREES

Bachelor of Science — Major in Computer Science (122 Term Credit Hours)
Bachelor of Science — Major in Computer Science with a Pre-Medical Specialization (129 Term Credit Hours)
Bachelor of Science in Computer Engineering (127 Term Credit Hours)
Bachelor of Science — Major in Management Science (122 Term Credit Hours)
Bachelor of Arts — Major in Computer Science (122 Term Credit Hours)

DUAL DEGREE PROGRAM

The School of Engineering and Applied Science offers a dual degree with the Meadows School of the Arts that leads to the degrees of Bachelor of Arts in Music and Bachelor of Arts in Computer Science. Please contact the department for additional details.

COMPUTING FACILITIES

Students in the Department of Computer Science and Engineering have access to a wide range of facilities and equipment. The department's computing environment has evolved into an Ethernet-based network of microcomputers and workstations. It now includes workstations from Sun Microsystems and Digital Equipment Corporation.

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 provides the student with a solid understanding of these concepts, which provides him or her with the technical knowledge needed to pursue either an advanced degree or a challenging career in the computer industry. The diversity of the SEAS computer environment exposes undergraduate computer science students to many different hardware and software systems.

To study and use computers we 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 PASCAL, LISP, C, Ada, PROLOG, APL, Smalltalk, Java, and C++ — that simplify the use of computers. In addition, the student is exposed to a variety of Computer Aided Software Engineering (CASE) 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 and data structures, graph theory, and Boolean and linear algebra are taken by undergraduates so that they may better understand the internal structure of the computer and the effective utilization of its languages.

A knowledge of the computer's internal structure is important to understanding its capabilities. Thus, the Computer Science student will 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 our students for advanced systems and software applications.

The free electives in the Computer Science program can also be used to individually tailor a student's study plan. For example, a student desiring a program even more intensive than the Computer Science major could satisfy his or her free electives with more Computer Science courses. A student wishing to obtain a broader education could satisfy these electives with courses offered by any department in the University.

BACHELOR OF SCIENCE WITH A MAJOR IN COMPUTER SCIENCE

Curriculum Requirements:

Area	*Required Courses*	*TCH*
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, 3353	9
	MATH 2339 *or* CSE 3353	3
	CSE 3365, 4340	6
Science:	PHYS 1105, 1106, 1303, 1304	8
	Six TCH from the following list of courses:	6
	ANTH 2315, 2363	
	BIOL 1401, 1402	
	CHEM 1113/1303, 1114/1304, 1307, 1308	
	GEOL 1301, 1305, 1307, 1308, 1313	
	PHYS 3305	
Computer Science:	CSE 1341, 2340, 2341, 2353, 3100, 3342, 3358, 3381, 4345, 4346, 4381, 5343	34
	12 TCH from the folowing, with exactly one selected from each area:	12
	Area I: CSE 5320, 5330, 5350	
	Area II: CSE 5381, 5385	
	Area III: CSE 5341, 5342, 5348	
	Area IV: CSE 5313, 5314, 5345, 5382	
Engineering:	EE 1381	3
Broadening:	ENGL 2301, CSE 3150	4
Free Electives:	The free electives must be approved by the adviser.	8
Wellness:		2
		122

BACHELOR OF SCIENCE WITH A MAJOR IN COMPUTER SCIENCE
With Pre-Medical Specialization

Curriculum Requirements:

Area	*Required Courses*	*TCH*
Liberal Studies:	ENGL 1301, 1302	6
	Perspectives — 9-12 hours	

	Cultural Formations — 3-6 hours (One Perspectives course *or* one Cultural Formations course must satisfy the Human Diversity requirement.)	
Mathematics:	MATH 1337, 1338, 3353	9
	MATH 2339 *or* CSE 3353	3
	CSE 4340	3
Science:	PHYS 1105, 1106, 1303, 1304	8
	BIOL 1401, 1402, 3304, 3306	14
	CHEM 1303, 1304; 1113; 1114; 3117; 3118; 3371, 3372	16
Computer Science:	CSE 1341, 2340, 2341, 2353, 3100, 3342, 3358, 3365, 3381, 4345, 4346, 4381, 5343	37
	12 TCH from the folowing, with exactly one selected from each area: Area I: CSE 5320, 5330, 5350 Area II: CSE 5381, 5385 Area III: CSE 5341, 5342, 5348 Area IV: CSE 5313, 5314, 5345, 5382	12
Broadening:	ENGL 2301, CSE 3150	4
Wellness:		2
		129

BACHELOR OF ARTS WITH A MAJOR IN COMPUTER SCIENCE

Curriculum Requirements:

Area	*Required Courses*	*TCH*
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
	MATH 2339 *or* CSE 3353	3
	STAT 2331	3
Science:	PHYS 1313	3
	Three TCH from the following list of courses: ANTH 2315, 2363 BIOL 1303, 1305, 1306, 1307, 1308, 1401, 1402 CHEM 1301, 1302, 1303, 1304, 1307, 1308 GEOL 1301, 1305, 1307, 1308, 1313 PHYS 1303, 1304, 1309, 1314, 1407, 1408, 3305	3
Computer Science:	CSE 1341, 2340, 2341, 2353, 3100, 3342, 3358, 3381, 4345, 4346, 5343	31
	Nine TCH from the folowing, with exactly one selected from each area: Area I: CSE 4381, 5320, 5330, 5350, 5381, 5385 Area II: CSE 5341, 5342, 5348 Area III: CSE 5313, 5314, 5345, 5382	9
Engineering:	EE 1381	3
Broadening:	ENGL 2301, CSE 3150	4
Free Electives:	The free electives must be approved by the adviser.	28
Wellness:		2
		122

MINOR IN COMPUTER SCIENCE*

I. Requirements:
1. CSE 1341 Principles of Computer Science I
2. CSE 2341 Principles of Computer Science II
3. CSE 2353 Discrete Computational Structures
4. CSE 3358 Data Structures

II. Elective Courses (two of the following)
1. CSE 3342 Programming Languages
2. CSE 5320 Artificial Intelligence
3. CSE 5330 File Organization and Database Management
4. CSE 5343 Operating Systems and System Software
5. CSE 5350 Algorithms Engineering

*A student minoring in Computer Science may not minor in Computer Engineering.

CURRICULUM IN COMPUTER ENGINEERING

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

The career opportunities of the computer engineer will require a broad range of knowledge. The design and analysis of logical and arithmetic processes that are the basis of computer science provides basic knowledge. Computer engineering courses are concentrated on the interacting nature of hardware and software. Basic electrical engineering is a clear foundation for the computer engineer. The Computer Engineering Program at SMU is accredited by ABET.

BACHELOR OF SCIENCE
WITH A MAJOR IN COMPUTER ENGINEERING

Curriculum Requirements:

Area	*Required Courses*	*TCH*
Liberal Studies:	ENGL 1301, 1302	6
	Perspectives — 9-12 hours	
	Cultural Formations — 3-6 hours	
	(One Perspectives course *or* one Cultural Formations course must satisfy the Human Diversity requirement.)	15
Mathematics:	MATH 1337, 1338, 2339, 2343, 3353	12
	MATH 2339 *or* CSE 3353	3
	CSE 3365, 4340	6
Science:	PHYS 1106, 1303, 1304	7
	CHEM 1303	3
	Three TCH from CHEM 1304; BIOL 1401, 1402; GEOL 1301; PHYS 3305	3
Engineering Core:	EE 1381, 2122, 2152, 2322, 2350, 2352	14
	ME 1302	3
	Three TCH from ME 2310, 2320, 2331, 3332, 3341	3
Computer Science:	CSE 1341, 2340, 2341, 2353, 3100, 3342, 3358, 3381, 4345, 4346, 4381, 5343, 5381, 5385	40
	Six TCH from CSE 5313, 5314, 5320, 5330, 5341, 5348, 5350; EE 5357, 5380	6
Broadening:	ENGL 2301, CSE 3150	4
Wellness:		2
		127

MINOR IN COMPUTER ENGINEERING*

I. Requirements:
1. CSE 1341 Principles of Computer Science I
2. CSE 2341 Principles of Computer Science II
3. CSE 2353 Discrete Computational Structures
4. CSE 3358 Data Structures

II. Elective Courses (two of the following):
1. CSE 4381 Digital Computer Design
2. CSE 5343 Operating Systems and Software
3. CSE 5381 Computer Architecture I
4. CSE 5385 Microprocessor Architecture and Interfacing

*A student minoring in Computer Engineering may not minor in Computer Science.

CURRICULUM IN MANAGEMENT SCIENCE

Management Science deals with the development of mathematically based models for planning, operating, and decision-making. In our curriculum, these methods are also applied to the design and management of efficient production systems.

Using American Airlines as an example, a management scientist would be concerned with building models to decide the best scheduling of flights, routing of planes, assignment of pilots and crews to specific flights, and flight gate assignments, as well as deciding the best number of planes to own and operate, which cities to fly to, which cities to use as major hubs, how to lay out an airport terminal, which overbooking policy should be used, and other issues. The optimal decisions for such issues can be uncovered through analysis using computer-based mathematical models. Hence, the management scientist uses the data collected and managed by the MIS department in building his or her models.

Because of its generality, Management Science has a broad set of applications in all engineering disciplines and in the fields of computer science, economics, finance, marketing, medicine, transportation, production, and statistics, for example. The methods are used extensively in both the public and private sector.

BACHELOR OF SCIENCE WITH A MAJOR IN MANAGEMENT SCIENCE

Curriculum Requirements:

Area	*Required Courses*	*TCH*
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, 2339, 3353	9
	MATH 2339 *or* CSE 3353	3
	CSE 4340, 5377	6
Science:	3 TCH Natural Science from BIOL 1401, 1402, CHEM 1113/1303, 1114/1304, 1113/1307, 1114/1308, GEOL 1301, 1305, 1308, PHYS 1105/1303, 1106/1304	3
	3 TCH Natural Science or Technology from ANTH 2315, 2363; BIOL 1303, 1304, 1305, 1401, 1402; CHEM 1113/1303, 1114/1304, 1113/1307, 1114/1308; GEOL 1301, 1305, 1307,	

	1308, 1315; PHYS 1403, 1404, 1407, 1408; EE 1301, 1381; ME 1301, 1302, 1303, 1304	3
	9 TCH Natural Science, Technology, and/or Social Science including ANTH, ECO, PSYC, or SOCI	9
Major Concentration:	CSE 1341, 2341, 2360, 3360, 3365, 4395, 5362	21
	3 TCH from CSE courses at the 2000 level or above	3
Business:	ACCT 2311, MKTG 3340, OBBP 3370	9
Broadening:	ENGL 2301, CSE 3150	4
Electives:	Adviser must approve electives	17
Free Electives:	Adviser must approve electives	6
Wellness:		2
		122

MINOR IN MANAGEMENT SCIENCE

For information on a minor in management science, the student should consult the department. A total of 15 TCH in management science courses is necessary to meet the following requirements:

I. Requirements:
1. CSE 1341 Principles of Computer Science I
2. CSE 2341 Principles of Computer Science II
3. CSE 2360 Engineering Economy
4. CSE 3360 Operations Research Models

II. Elective Courses (two of the following – students must include one of CSE 4395 or CSE 5362):
1. CSE 4340 Statistics for Engineers and Applied Scientists
2. CSE 4395 Senior Design
3. CSE 5362 Production Management
4. CSE 5377 Statistical Design and Analysis of Experiments

THE COURSES (CSE)

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 CS, CpE, or MS major or minor.

1311. Introduction to Interactive Multimedia. An introduction to multimedia hardware technologies, software systems, and standards used to develop interactive multimedia applications. Topics include screen design, graphics, animation, audio, and still and motion video, as well as compression techniques. Each student will design personal multimedia Web pages that will include one common class theme plus a variety of personally selected subjects. *Prerequisite:* CSE 1305 or permission of instructor.

1340. Introduction to Computing Concepts. Introduction to computer concepts and structures and interactive application development. Programming with high-level languages, tools, and environments. Laboratory exercises will include programming assignments.

1341. Principles of Computer Science I. Introduction to the fundamental concepts of computer science – algorithms, program structures, data structures. Structured programming in C. Development of programming skills to solve problems of reasonable complexity. Introduction to UNIX. The first course for CS and CpE majors and minors. 0.5 TCH Design. *Prerequisite:* An introductory programming course.

2336. Visual Basic Programming. Introduction to programming using the Visual Basic environment, with focus on business applications. Software development life cycle, flowcharts, data types, control structures, debugging techniques, design and implementation of graphical interfaces, report generation, Visual Basic as a front end for database access. Students are required to design and write code. No prior programming experience required. No credit for CSE majors or minors. *Prerequisite:* CSE 1305 or permission of instructor.

2337. Introduction to Database Design and SQL. This course is designed to provide practical experience in using SQL and ACCESS 2000. It emphasizes hands-on practical training in implementing and accessing relational databases. No credit for CS and CpE majors or minors. *Prerequisite:* Familiarity with Microsoft Word and Excel packages and both creating and editing files in a Windows environment.

2340. Assembly Language Programming and Machine Organization. Computer number systems, arithmetic operations, machine organization, machine language, assembly language programming. 0.5 TCH Design. *Prerequisites:* CSE 1302, 1316, 1317, or 1341.

2341. Principles of Computer Science II. This course is intended as a continuation of CSE 1341, further developing program design skills and understanding of language concepts. Thorough coverage of the C programming language. Implementation of basic data structures (linked lists, stacks, queues, sets, and binary trees) and their use in efficient program design. 1 TCH Design. *Prerequisite:* CSE 1341.

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. 0.5 TCH Design. *Prerequisite:* CSE 1341, MATH 1338.

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. *Prerequisite:* MATH 1338 and a knowledge of finite probability.

3100. Digital Logic Design Laboratory. Complements basic courses in computer organization, logic, and switching theory. Emphasizes interconnection of logic modules to obtain counters, control circuits, arithmetic units, memories, and small computer circuits. 1 TCH Design. *Corequisite:* CSE 3381.

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.

3342. Programming Languages. Introduction to basic concepts of programming languages, including formal syntax, static and dynamic, scoping, equivalence and consistency of data types, control constructs, encapsulation and abstract data types, storage allocation, and runtime 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. 1 TCH Design. *Prerequisite:* CSE 2341.

3353. Discrete Mathematics With Algorithms. Introduction to algorithm analysis, big Oh notation, classifying algorithms by efficiency. Algorithms for arithmetic operations, binomial coefficients, prime factorization, gcd. Sorting and selection algorithms. Introduction to graph theory, graph algorithms. *Prerequisite:* CSE 2353.

3358. Data Structures. Representation and organization of data for fast access and computation. Consideration of efficient algorithms for storing and retrieving information using lists, trees, hash tables, etc. Dynamic storage allocation/collection techniques. Fast sorting techniques. Abstract data types (ADT). Implementation of data structures. 1 TCH Design. *Prerequisites:* CSE 2341 and 2353 or MATH 3308.

3360. Operations Research. A survey of models and methods of operations research. Deterministic and stochastic models in a variety of areas will be covered. Credit is not allowed for both CSE 3360 and CSE 6360. *Prerequisites:* A knowledge of matrices. An introduction to probability and statistics.

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 C or FORTRAN programming, algorithm implementations, and library codes. *Prerequisites:* CSE 1341 and a grade of *C*- or higher in MATH 1338. Students registering for this course must register for an associated computer laboratory.

3381. Digital Logic Design. Boolean functions. Logic gates. Memory elements. Synchronous and asynchronous circuits. Shift registers and computers. Logic and control. 1 TCH Design. *Corequisite:* CSE 3100; *Prerequisites:* CSE 2340, 2353.

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:* MATH 1338.

4345. Software Engineering Principles. Provides practical experience in proposal development, software system design, implementation, and validation. Integrates and develops skills in applied computer science, project management, communication, problem solving, design and validation methodology. Review of current software engineering literature. 1.5 TCH Design. *Prerequisites:* CSE 3358 and senior standing.

4346. Software Engineering Laboratory IV. Provides a project-contract environment for implementation of systems designed in CSE 4345. Emphasizes working from a set of specifications as a project team member. Project team organization. Project planning, scheduling, and management. Testing and validation methods. 3 TCH Design. *Prerequisite:* CSE 4345 or permission of instructor.

4381. Digital Computer Design. Machine organization, instruction set architecture design, memory design, control design: hardwired control and microprogrammed control, I/O organization, algorithms for computer arithmetic, computer peripherals, microprocessors, and Hardware Description Languages (HDLs) and simulations based on them. 1 TCH Design. *Prerequisite:* CSE 3381, or both EE 2381 and CSE 2340.

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. This course consists of a large project involving the design of a management system. The project will involve model building, data collection and analysis, and evaluation of alternatives. 3 TCH Design. *Prerequisites:* CSE 5362 and senior standing.

5313. Software Requirements and Design Engineering. This course focuses on defining software requirements and provides an overview of design techniques that can be used to structure applications. Requirements topics include interacting with end users to determine needs and expectations, identifying functional requirements, and identifying performance requirements. Techniques studied include prototyping, modeling, and simulation. Design topics include design in the system life cycle, hardware vs. software trade-offs, subsystem definition and design, abstraction, information hiding, modularity, and reuse. 1.5 TCH Design.

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. 1 TCH Design.

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. 1 TCH Design. *Prerequisites:* CSE 3342, 3358.

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, implementation constraints. Applications of large databases. Includes a survey of file structures and access techniques. Use of a relational DBMS to implement a database design project. 1.5 TCH Design. *Prerequisite:* CSE 3358.

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. 1 TCH Design. *Prerequisites:* CSE 3342, 3358.

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. 1 TCH Design. *Prerequisite:* CSE 3342 or permission of instructor.

5343. Operating Systems and System Software. Theoretical and practical aspects of operating systems: overview of system software, time-sharing and multiprogramming operating systems, network operating systems and the Internet, virtual memory management, interprocess communication and synchronization, file organization, and case studies. 1 TCH Design. *Prerequisites:* CSE 2340, 3358.

5345. Advanced Java Programming. This course will provide the student with a foundation for building advanced distributed and embedded systems applications in Java through the use of Java's support for networking and concurrency. Topics will include exception handling, object serialization, thread and thread-safe programming issues, component frameworks, remote method invocation, security, and concurrency issues. Discussion of the issues and techniques necessary to develop high-performance, object-oriented concurrent Java applications and be able to apply advanced Java constructs to research projects in telecommunications, databases, networks, and mobile computing. *Prerequisites:* CSE 3342 or permission of instructor.

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, internetworking over new networking technologies. 1 TCH Design. *Prerequisites:* CSE 5343 and C programming.

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. Developing student facility to design efficient algorithms is emphasized. 1 TCH Design. *Prerequisite:* CSE 3358.

5362. Production Management. A survey of models and methods for designing and implementing quality-based, integrated, production/distribution systems. Topics include demand forecasting, product mix decisions, distribution systems, facilities location and layout, scheduling, inventory and materials management, just-in-time, and quality control for manufacturing and service operations. *Prerequisite:* CSE 3360.

5376 (EE 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. 0.5 TCH Design.

5377 (STAT 5377). Statistical Design and Analysis of Experiments. Introduction to statistical principles in the design and analysis of industrial experiments. Completely randomized, randomized complete and incomplete block, latin square, and Plackett-Burman screening designs. Complete and fractional factorial experiments. Descriptive and inferential statistics. Analysis of variance models. Mean comparisons. *Prerequisites and corequisites:* CSE 4340 and senior standing with a Science or Engineering major, or permission of instructor.

5381. Computer Architecture I. An advanced course in computer architecture introducing students to the state of the art in uniprocessor computer architecture. The focus is on the quantitative analysis and cost-performance trade-offs in instruction-set, pipeline, and memory design. Description of real systems and performance data also are presented, providing qualitative case studies that complement the quantitative analysis. Topics covered: quantitative performance measures, instruction set design, pipeline, vector processing, memory organization, input/output, and an introduction to parallel processing. *Prerequisites:* CSE 4381. Reasonable experience with any high-level language and any hardware description language.

5382. Computer Graphics. Hardware and software components of computer graphics systems: display files, two-dimensional and three-dimensional transformations, clipping and windowing, perspective, hidden line elimination and shaping, interactive graphics, and applications. 1 TCH Design. *Prerequisite:* CSE 3358 or equivalent.

5385. Microprocessor Architecture and Interfacing. Emphasizes the design of Intel-based microprocessor computer systems. The course starts with the presentation of Intel microprocessors and continues with the design of a personal computer system with hierarchical memory, input-output peripherals, and industry-standard bus interfaces (ISA, EISA, VLB, and PCI). In addition to hardware design techniques, the course has laboratory and design projects in which students learn to use state-of-the-art CAD tools and laboratory instruments for hardware design, simulation, implementation, and debugging. 2 TCH Design. *Prerequisites:* CSE 3381 or both EE 2381 and CSE 2340.

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

ELECTRICAL ENGINEERING

Professor Gibson, *Chair*

Professors: J. Butler, Çelik-Butler, Evans, Gosney, Gupta, Khotanzad, Peikari, Srinath; *Associate Professors:* D. Butler, Chen, Davila, Douglas, Dunham, Lee, Orsak; *Adjunct Associate Professors:* Ku, McMahon, Provence, R. Sharma; *Adjunct Assistant Professors:* Abuzaid, Levine, Loos, Pucacco, Rahman, Sohl, Triggs, Westerhold; *Emeritus Professors:* Ashley, Fossum, Heizer, Howard, Savage, Vacroux; *Senior Lecturer:* Baker.

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 we 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 expanding 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, information technology, communication networks, digital signal processing, lasers and optoelectronics, electromagnetics and microwaves, microelectronics, VLSI design, systems and control, and image processing and computer vision. The courses and curriculum are designed and continuously updated to prepare the student for a successful career in engineering design and development at the forefront of these fields — or, if desired, to allow the student to pursue an advanced degree in electrical engineering.

In addition to the B.S.E.E. degree, a professionally oriented Bachelor's degree in telecommunications systems is offered through the Electrical Engineering Department. The courses in this curriculum provide an overview of the telecommunications industry and prepare the student to become immediately involved in the development of new telecommunications products, services, and applications.

The SMU Electrical Engineering Department emphasizes the following major areas of 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 waveguides, 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, VLSI design, neural network implementation, parallel array architectures, 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 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 SEAS academic computing resources, which consist of four 600-MHz Digital Workstations, four multiprocessor 300-MHz Digital 2100 servers, five DecStation 5000/260s, and two 250-MHz Sun Ultra Enterprise 3000 servers. A DEC 8200 with dual 300-MHz processors and 2GB of RAM will accept batch jobs up to 9GB. SEAS file service is provided by a High Availability Digital clustered NFS/CIFS file server FibreChannel connected to RAID 3/5 disk arrays. Current capacity is 324 GB, with possible expansion to more than 9TB. The file server is connected to the Gigabit Ethernet backbone and serves all Unix machines and PCs in SEAS. An Auspex 7000/300 with 116GB is also available and is connected to the secondary FDDI backbone.

All SEAS resources are connected to SEASnet, which consists of a Gigabit Ethernet backbone with various segments connected via FDDI, 100Mb Ethernet, 10Mb Ethernet, and OC3 ATM.

Specific department laboratory facilities for instruction and research include:

BIOMEDICAL ENGINEERING LABORATORY. This lab is equipped to provide students with facilities for the study of a wide variety of problems in biomedical engineering. Equipment includes a Nikon light microscope, infrared spectrophotometer, thermograph, 4 Grass physiographs, personal computer with data acquisition capability, a variety of analog and digital oscilloscopes, signal generators, and meters.

CRYOELECTRONICS LABORATORY. The cryoelectronics laboratory is used in the investigation of electronic materials and devices at cryogenic temperatures and provides measurement capabilities from 2K to 450K. Two low-temperature Dewars, two closed-cycle helium refrigerators, one open-cycle helium cryostat, various cryogenic inserts, microprocessor-based programmable temperature controllers, temperature sensors, and fiber-optic instrumentation support low-temperature device characterization and superconductivity research. Two computer workstations are used as system controllers for data acquisition and modeling. There is close interaction with the Solid-State Device Characterization and the Microwave Electronics laboratories.

SOLID-STATE DEVICE CHARACTERIZATION LABORATORY. This facility is used for the characterization and modeling of solid-state devices and electronic materials. The laboratory has the capability for computerized I-V, C-V, microwave, optical, and noise characterization of devices. This lab is designed for computer-controlled data acquisition and modeling.

The electrical and noise-characterization facilities include an HP-UX workstation running IC-CAP with a HP4142 source monitor unit, HP4284 LCR meter for I-V and C-V characterization, and two magnets. The lab also contains a 6x6-ft shielded room with a noise attenuation of 100 dB to electric fields and plane waves from 14 kHz to 10 GHz and 30 dB to magnetic fields at 60 Hz. The lab includes two low-frequency dynamic signal analyzers, lock-in amplifiers, various programmable multimeters, oscilloscopes, and LCR meters, plus plotters, printers, and system controllers.

The microwave measurement equipment includes a 200-KHz to 22-GHz HP71200A spectrum analyzer, an HP8510 (40 MHz to 40 GHz) network analyzer, an HP54120T 20 GHz sampling oscilloscope, microwave power meters, and various microwave components and amplifiers. The optical characterization facilities include an Oriel MS257 spectrometer/monochrometer, two IR sources, a calibrated pyroelectric detector, various fiber-optic components, laser diodes, and Ortel 7 GHz photodiodes. The spectrometer/monochrometer and IR sources allow the characterization of devices and materials from one to 12 xmicrons.

PULSED LASER DEPOSITION LABORATORY. This facility is a Neocera turn-key pulsed laser deposition system, consisting of an 18-inch turbo-pumped vacuum chamber. The system has a three-inch *rf* sputter gun in addition to a six-target PLD carousel. The substrate can be heated to 950 C. The system uses a Lambda-Physik Compex 301 KrF excimer laser operating at 248 nm. The laser produces up to one joule per pulse with a repetition rate of one to 10 Hz. The PLD system is used primarily for the deposition of ferroelectric and pyroelectric materials used in uncooled infrared detectors. Other bolometric, superconductive, and optoelectronic materials are also investigated.

MICROWAVE ELECTRONICS LABORATORY. The lab uses HP-Series IV software, including the CAE packages Touchstone, Libra, OmniSys, J-Omega, and Communications Design Suite. The software is used for education in the design and analysis of microwave circuits and system. Also included in the facility are a 20-GHz sampling oscilloscope, microwave frequency synthesizers, microwave power meter, pulse generator, 22-GHz HP71200A spectrum analyzer, and a 40-GHz HP8510 network analyzer plus microwave amplifiers, mixers, and components.

Optoelectronics Simulation Laboratory. Software programs to assist with the design of semiconductor optoelectronic devices have been evolving at SMU for decades and are currently used to design the epitaxy structures for strained-quantum-well semiconductor lasers and to predict the resulting device performance. These programs deal with three broad areas: 1) quantum-well gain optimization, 2) electromagnetic and optical field optimization, and 3) periodic structures and gratings. In addition to distributed feedback and distributed Bragg reflector laser design, grating software is used in the study of grating-assisted coupling between dielectric waveguides. MODEIG software (available free at www.seas.smu.edu/modeig/), used for solving the propagation characteristics of optical waveguides, is maintained and regularly upgraded by this laboratory. It is used by more than 50 corporations, universities, and government agencies worldwide. Students use software developed in this laboratory for assignments and projects.

Solid-State Technology Laboratory. The facility consists of a 3,000-square-foot Class 10,000 clean room with Class 100 laminar-flow work areas. Major equipment includes two projection printers and two contact printers for lithography; a plasma reactor for etching and deposition of dielectrics; an *rf/dc* sputter deposition system; two plasma etch systems; two reactive-ion etch systems; and a chemically assisted ion-beam etch system. Also available are e-beam evaporators for metallization and dielectric deposition; a thermal evaporator for metal deposition; a pulsed-laser deposition system; a scanning electron microscope; and oxidation, diffusion, and annealing furnaces. In addition to its instructional uses, this laboratory supports research in laser diodes, uncooled infrared detectors, microelectromechanical (MEM) devices, and NbN and YBaCuO superconductor devices.

Submicron Grating Laboratory. This laboratory is dedicated to the holographic fabrication of submicron gratings. Equipment includes a floating optical table, a visible argon ion laser, an ultraviolet argon ion laser, laser power meter, and optical components for holography. Typical grating linewidths range from 0.09 to 0.5 μm and can be specified to an accuracy of +0.0001 μm. In addition to supporting research on semiconductor lasers and telecommunications components, this laboratory is used by students to fabricate gratings.

Semiconductor Laser Characterization Laboratory. This laboratory is dedicated to measuring the performance of edge-emitting and surface-emitting semiconductor lasers fabricated at SMU from materials including AlGaAs, InGaAs, InGaAsP, AlGaInAs, and AlGaInP with wavelengths ranging from 0.63 to 2 μm. Equipment and instrumentation include optical spectrometers, visible and IR cameras and detectors for near-field and far-field measurements, power supplies for light-current measurements, temperature-controlled stages for laser characterization, and custom assemblies of optical components on two floating optical tables. Commercial beam-analysis software is used with several optical set-ups to characterize laser beams, and several of the semiconductor laser evaluation stations are computer-controlled. An automated probe station is used to evaluate vertical cavity surface-emitting lasers (VCSELs). In addition to laser research, students use this laboratory to produce video "virtual laboratory" experiences for distance students.

Digital Signal Processor Laboratory. Digital signal processors (DSPs) 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 TMS320C50, a fixed-point processor, with emphasis on assembly-language programming, implementation of FIR and IIR filters, the FFT, and a real-time spectrum analyzer.

Communications Systems Simulation Laboratory. The lab consists of 12 high-speed Silicon Graphics Workstations with a large-screen projection system. These integrated multimedia workstations run a wide array of communication system design and analysis software, signal processing software, and multimedia and Web-based software tools.

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

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:

- Control Systems
- Biomedical Engineering
- Communications
- Computer Engineering
- Digital Signal Processing
- Electromagnetics and Optics
- Electronic Circuits
- Electronic Devices and Materials
- Networks
- Systems
- Telecommunications Engineering

In most cases, the concentration is satisfied by systematically taking a specified group of electrical engineering courses at the advanced level. However, the telecommunications engineering, computer engineering, and biomedical options are more specialized. Their requirements are described later.

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

The electrical engineering curriculum is administered by the Department of Electrical Engineering and is accredited by the Accreditation Board of Engineering and Technology (ABET).

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

Term Credit Hours	
124	Minimum total hours required
23	*College Requirements* (ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations, and Wellness)
15	*Mathematics* (MATH 1337, 1338, 2339, 2343, and a three-hour elective course at the 3000 level or above)
13	*Science* (CHEM 1303 or 1305; PHYS 1303, 1304, and 1105; and a three-hour elective in physics or chemistry)
3	*Mathematics or Science Elective* (a three-hour course approved by adviser)
6	*Computer Science* (CSE 1341 and one of CSE 2340, 2341, 2353, 3342, or 3358)

6	*Technical Electives* from other SEAS departments
6	*Mechanical Engineering Fundamentals* (ME 1302 and one of ME 2310, 2320, 2331, 3332, or 3340)
20	*Core Electrical Engineering* (EE 1381, 2381, 2350, 2170, 2370, 2122, 2322, and 3360)
11	*Junior Electrical Engineering Electives* (three of EE 3311, 3322, 3330, 3362, 3372, and 3381; and EE 3122 and 3181)
15	*Advanced Electrical Engineering Electives*
6	*Electrical Engineering Senior Design Sequence* (EE 4311, 4312)

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

I. EE 4372, 4373, 5360, 5362, 5370, 5371, 5373, 5374, and 5375;
II. EE 5356, 5357, 5380, 5381, and 5385; and
III. EE 5310, 5312, 5315, 5321, 5330, and 5332.

The remaining six hours of advanced electrical engineering electives may be chosen from any of the above three areas, the telecommunications courses offered by the EE Department, or advanced (5000-level) CSE courses offered by the CSE Department. 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 four important areas: pre-medical or biomedical engineering, computer engineering, a dual degree in physics, and telecommunications engineering. 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 Engineering 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, and it is carried out in cooperation with the Baylor University Medical Center in Dallas. Students may also work on projects under faculty supervision at the University of Texas Southwestern Medical School.

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

Term Credit Hours	
128	Minimum total hours required
23	*College Requirements* (ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations, and Wellness)
15	*Mathematics* (MATH 1337, 1338, 2339, 2343, and a three-hour elective course at the 3000 level or above)
36	*Science* (BIOL 1401, 1402, 3304, and 3306; CHEM 1303, 1304, 1113, 1114, 3117, 3118, 3371, and 3372; and PHYS 1303 and 1304*)
3	*Computer Science* (CSE 1341)
6	*Mechanical Engineering Fundamentals* (ME 1302 and one of ME 2310, 2320, 2331, 3332, or 3340)

20	*Core Electrical Engineering* (EE 1381, 2381, 2350, 2170, 2370, 2122, 2322, and 3360)
7	*Junior Electrical Engineering Electives* (EE 3181, 3381; one of EE 3311, 3315, 3330, 3372, and 3381
6	*Advanced Electrical Engineering Electives*†
6	*Biomedical Engineering* (EE 5340 and 5345)
6	*Electrical Engineering Senior Design Sequence* (EE 4311, 4312)

* Students who plan to attend medical school are recommended to also take PHYS 1105 and 1106.

† Advanced EE electives must be chosen so there will be a minimum of 16 TCH of design.

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	
124	Minimum total hours required
23	*College Requirements* (ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations, and Wellness)
15	*Mathematics* (MATH 1337, 1338, 2339, 2343, and 3308)
13	*Science* (CHEM 1303 or 1305; PHYS 1303, 1304, and 1105; and a three-hour elective in physics or chemistry)
3	*Mathematics or Science Elective* (a three-hour elective approved by the adviser)
12	*Computer Science* (CSE 1341, 2341, and 3358; and one of CSE 2340 or 3342)
6	*Mechanical Engineering Fundamentals* (ME 1302 and one of ME 2310, 2320, 2331, 3332, or 3340)
20	*Core Electrical Engineering* (EE 1381, 2381, 2350, 2170, 2370, 2122, 2322, and 3360)
11	*Junior Electrical Engineering Electives* (EE 3122, 3181, 3322, and 3381; and one of EE 3311, 3330, or 3372)
15	*Advanced Electrical and Computer Engineering Electives* (EE 5381 or CSE 4381; EE 5385 or CSE 5385; two of EE 5357, 5380, and CSE 5343; and a three-hour elective approved by the adviser)
6	*Electrical Engineering Senior Design Sequence* (EE 4311, 4312)

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 Bachelor of Science in Electrical Engineering (B.S.E.E.) degree and a Bachelor of Science (B.S.) degree with a major in Physics.

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

Term Credit Hours	
135	Minimum total hours required
23	*College Requirements* (ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations, and Wellness)
15	*Mathematics* (MATH 1337, 1338, 2339, 2343, and a three-hour elective course at the 3000 level or above)
33	*Science* (CHEM 1303 or 1305; PHYS 1105, 1303, 1304, 3305, 3344, 3345, 4211, 5337, 5382, and 5383; and PHYS 3374 or ME 3341)
6	*Computer Science* (CSE 1341 and one of CSE 2340, 2341, 2353, 3342, or 3358)
6	*Mechanical Engineering Fundamentals* (ME 1302 and one of ME 2310, 2320, 2331, 3332, or 3340)
20	*Core Electrical Engineering* (EE 1381, 2381, 2350, 2170, 2370, 2122, 2322, and 3360)
11	*Junior Electrical Engineering Electives* (EE 3330 or PHYS 4392; two of EE 3311, 3322, 3362, 3372, and 3381; and EE 3122 and 3181)
15	*Advanced Electrical Engineering Electives*
6	*Electrical Engineering Senior Design Sequence* (EE 4311, 4312)

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

(Communication and Signal Processing Specialization)

Signal processing in particular digital signal processing (DSP), has come to play a significant role in our daily lives. Literally, DSP involves the processing of various signals such as speech, music, video, and others in digital form. Such processing is usually done with a digital signal processor, a programmable semiconductor device designed to rapidly process digital data. The DSP is an integral component of any system in which information is processed or transmitted, whether over a conventional telephone network, a cellular phone, or the Internet.

The explosive growth of the telecommunications industry and the Internet has generated a tremendous demand for electrical engineers who are versed in the language of DSP. The Communication and Signal Processing specialization is designed to meet this need. Students learn the fundamental principles of DSP during the first year. Concepts and techniques in signal processing and communications are covered in greater depth in each successive year, culminating in a senior-year capstone course in which students design and develop signal processing algorithms and software for a communications system application.

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

Term Credit Hours	
124	Minimum total hours required
23	*College Requirements* (ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations, and Wellness)
15	*Mathematics* (MATH 1337, 1338, 2339, 2343, and a three-hour elective course at the 3000 level or above)
13	*Science* (CHEM 1303 or 1305; PHYS 1303, 1304, and 1105; and a three-hour elective course at the 3000 level or above)
3	*Mathematics or Science Elective* (a three-hour course approved by the adviser)

12	*Computer Science* (CSE 1341, 2341, and 3358; and one of CSE 2340 or 3342)
6	*Mechanical Engineering Fundamentals* (ME 1302 and one of ME 2310, 2320, 2331, 3332, or 3340)
29	*Core Electrical Engineering* (EE 1381, 2381, 2350, 2170, 2370, 2122, 2322, 3330, 3360, 3372, and 3373)
14	*Advanced Communication and Signal Processing Courses* (EE 4173, 4372, 4373, 5176, 5373, and 5376)
3	*Advanced Electrical Engineering Electives* (one of EE 3322, 3381, 5321, 5340, 5345, 5360, 5371, 5374, 5380, and 5381)
6	*Electrical Engineering Senior Design Sequence* (EE 4311, 4312)

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING
(Telecommunications Specialization)

Telecommunications includes any type of communication of information at a distance by electronic means. This communication may be between humans, machines, businesses, government entities, computers, or any combination thereof. Example information formats include speech and audio, computer data, facsimile, imaging and video, wire and cable, radio, satellite, Internet, microwave, optical fiber, and others.

Today's intelligent networks, created by imbedding computers in telecommunications systems, have given rise to an information society. Corporations, institutions, and government agencied cannot operate effectively in a competitive world without using telecommunications systems efficiently to communicate that information.

All areas of the telecommunications profession need telecommunications engineers. In manufacturing, they work as creators and designers of products. In the service category, they create efficient and cost-effective systems for telephone service providers, Internet and online computer services, and cellular service providers. At the corporate-user end of the profession, they ensure that their companies have the very best telecommunications systems to give their businesses a competitive edge.

Telecommunications engineers face challenges requiring specialized training in electrical engineering, plus breadth that include regulatory law, economics, management science, and computer science. To ensure their success, SMU candidates for the degree of Bachelor of Science in Electrical Engineering with a telecommunications engineering specialization are grounded in all of these areas. To accomplish this within the context of a four-year program, students take a uniquely formulated curriculum of electrical engineering and telecommunications courses, plus specially selected courses relating to the multiple disciplines mentioned above. In this way, graduates are prepared to face information-age challenges and opportunities, whether in a corporate, institutional, or government environment.

SMU's long historic relationship with local industry provides a wealth of educational opportunities for students in terms of design projects, laboratories, field trips, and, at the student's option, cooperative education. SMU's Bachelor of Science in Electrical Engineering program with a telecommunications engineering specialization prepares students for careers with a large variety of producers, service providers, and users of telecommunications systems. Graduates of the program should have little difficulty finding employment in the immediate Dallas area or elsewhere.

This 124-term-credit-hour program has several distinctive features:

- Early development of research skills using computers and the Internet, allowing students to use these important tools throughout their college experience.
- Participation in student teams that work on a variety of industry-sponsored real-world laboratory projects under the joint guidance of faculty and industry representatives.

- Option of entering the Cooperative Education Program as explained in the Cooperative Education section to get more than a year of industry experience and income before graduation.

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

Term Credit Hours

124	Minimum number of hours required
23	*College Requirements* (ENGL 1301, 1302, Perspectives including ECO 1311, Cultural Formations, and Wellness)
18	*Mathematics* (MATH 1337, 1338, 2339, 2343, and 3308; and one of MATH 3315 or 3353)
13	*Science* (CHEM 1303 or 1305; PHYS 1303, 1304, and 1105; and a three-hour elective in physics or chemistry)
9	*Computer Science* (CSE 1341, 2341, and one of CSE 2360, 3342, or 3358)
6	*Mechanical Engineering Fundamentals* (ME 1302 and one of ME 2310, 2320, 2331, 3332, or 3340)
28	*Electrical Engineering* (EE 1381, 2381, 2350, 2170, 2370, 2122, 2322, 3330, 3360, 3181, 3381, and one hour of laboratory electives)
6	*Advanced Electrical Engineering* (EE 5370 and one of EE 4372, 5332, 5373, or 5381)
6	*Telecommunications* (EE 5301 and 5302)
9	*Advanced Electives* (nine hours of advanced electrical engineering or telecommunications engineering electives approved by adviser)
6	*Telecommunications Senior Design Sequence* (EE 4301 and 4302)

MINOR IN ELECTRICAL ENGINEERING

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

I. Requirements:
   1. EE 2322 Electronic Circuits I
   2. EE 3322 Electronic Circuits II
   3. EE 2350 Circuit Analysis I
   4. EE 2370 Design and Analysis of Signals and Systems

II. Elective Courses:
   Six TCH of electrical engineering courses at the 3000 level or above

BACHELOR OF SCIENCE WITH A MAJOR IN TELECOMMUNICATIONS SYSTEMS

SMU offers an applied science program leading to the degree of Bachelor of Science with a major in telecommunications systems. Graduates of this program may find career opportunities in the same kinds of institutions as telecommunications engineers. However, their job responsibilities may have an emphasis on systems management, technology liaison, or marketing rather than on systems design. Although students take some of the same telecommunications and electrical engineering courses as those in the B.S.E.E. program with Specialization in Telecommunications Engineering, they have more freedom in course selection.

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

Term-Credit Hours

122	Minimum number of hours required
29	*College Requirements* (ENGL 1301, 1302, Perspectives including ECON 1311, Cultural Formations, and Wellness)

6	*Mathematics* (MATH 1309 or 1337, and MATH 1310 or 1338)*
3	*Probability and Statistics* (STAT 2301, 2331 or STAT 4340/CSE 4340)
3	*Introductory Physics* (PHYS 1313 or 1407, or both 1303 and 1105)
6	*Computer Science* (CSE 1341 and 2341)
16	*Electrical Engineering* (EE 1381, 2355, 2356, 2381, 3181, 3381†)
18	*Telecommunications* (EE 1305, 3301, 3302, 5301, 5302, 5305)
6	*Telecommunications Senior Design Sequence* (EE 4301 and 4302)
3	*Engineering Economy* (CSE 2360)
9	*Business Administration* (ACCT 2311, MKTG 3340, OBBP 3370)
3	*Technical Writing* (ENGL 2301)
20	*Free Electives* (with adviser approval)

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* Students taking MATH 1309 and 1310 are strongly recommended to take CSE 2353 as one of their electives.

† EE 2152, 2350, and 2352 can substitute for EE 2355 and 2356.

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:

XX0X Telecommunications
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

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 non-technical students who want to be more knowledgeable. (Not open to EE majors.)

1305. Introduction to Modern Telecommunications. Non-analytical survey of modern communications systems used in business, government, and the home. Emphasis on future systems that will permeate our culture and Third-World cultures by the turn of the century, and on design issues and methodology in modern communications infrastructures. Contemporary computer and voice communications systems using wires, optical fibers, satellites, and various wireless techniques. Fundamental concepts and design methods. Public and private networks, including engineering management; economics; reliability; ethical, legal, and regulatory issues; security; and control.

1381. Introduction to Digital Systems. Fundamentals of logic design. Number systems, Boolean algebra, simplification methods, analysis and synthesis of combinational and sequential circuits, timing, and control. Students will meet in a laboratory for one and a half hours per week and will design, build, and test digital circuits. 1 TCH Design.

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. 0.5 TCH Design. *Prerequisite:* EE 2322.

2152. EE Laboratory: Electric Circuits. Cathode ray oscilloscope and its use. Transient response of networks composed of resistors, capacitors, and inductors. Steady-state sinusoidal response and frequency response of networks. Computer solution of linear circuits. *Prerequisite:* EE 2352.

2170. EE Laboratory: Design and Analysis of Signals and Systems Using MATLAB. This laboratory course introduces students to various techniques for analyzing real signals and designing various linear time-invariant systems. The lab will be conducted on high-end workstations using MATLAB and will give students additional experience using Web authoring tools for the production of multimedia lab reports. *Prerequisite:* CSE 1341.

2322. Electronic Circuits I. An introduction to nonlinear devices used in electronic circuits. The course will cover the DC analysis of circuits employing diodes, bipolar junction transistors, MOSFETs, and JFET. Introduction to AC analysis will be covered. Topics include device I-V characteristics, biasing, transfer characteristics, power dissipation, aspects of transient analysis, SPICE, and the mid-band analysis and design of amplifier circuits and logic circuits. 1 TCH Design. *Prerequisite:* EE 2350.

2350. Circuit Analysis I. Analysis of resistive electrical circuits, basic theorems governing electrical circuits, power consideration, analysis of circuits with energy storage elements. Transient analysis of circuits with inductors and capacitors. 0.5 TCH Design. *Prerequisite:* PHYS 1304. *Corequisite:* MATH 2343.

2352. Circuit Analysis II. Laplace transform and its application to circuit analysis. Immittance and network functions. Frequency response and Bode plots. Two-port parameters, power transfer, and insertion loss. 0.5 TCH Design. *Prerequisite:* EE 2350.

2355. Systems Analysis I. An elementary treatment of system analysis methods as applied to mechanical and electrical systems. Analysis of first- and second-order mechanical and electrical systems. *Prerequisites:* MATH 1309 and 1310, or 1337 and 1338.

2356. Systems Analysis II. Analysis of linear-time invariant systems. Sinusoidal steady-state analysis of mechanical and electrical systems, phasors, two-port parameters, and discrete systems. *Prerequisite:* EE 2355.

2370. Design and Analysis of Signals and Systems. This course introduces students to standard mathematical tools for analyzing and designing various signals and systems in both continuous and discrete time. Heavy emphasis is given to frequency domain design and analysis techniques as well as the Laplace Transform and Z-Transform. Other topics include the Sampling Theorem, the Fast Fourier Transform, and introductory spectral estimation techniques. *Prerequisites:* MATH 1337, 1338. *Corequisite:* EE 2170.

2381. Digital Computer Logic. Analysis and synthesis of combinational and sequential circuits, timing and control, read-only memories, programmed logic arrays, and random memories. Designing with integrated circuits. Students will meet in a laboratory for one and a half hours per week. 2 TCH Design. *Prerequisite:* EE 1381.

3(1-3)90. Junior Project.

3122. EE Laboratory: Electronic Circuits II. Experiments in analog electronic circuit design. 0.5 TCH Design. *Corequisite:* EE 3322.

3181. EE Laboratory: Microprocessors. Fundamentals of microprocessor design and assembly-language programming. An introduction to the 6811 Motorola Evaluation Board, 6811 Assembler, microprocessor-based system design, assembly programming, and hardware interfacing. *Corequisite:* EE 3381.

3301. Telecommunications Systems I. Architecture of the telecommunications industry, digital interfaces and connectivity, local area networks, and inter-networks. In the lab, consideration, measurement, and evaluation of the attributes of various types of terminals and data formatting promulgated by the EIA, ANSI, ITU, and IEEE for voice, data, image, video, etc., are studied, along with the impact of format on file sizes, buffer delays, throughput, and quality of results. 1 TCH Design. *Prerequisite:* EE 2356 or 2352.

3302. TELECOMMUNICATIONS SYSTEMS II. Architecture of the telecommunications industry, wide area networks, client/server architectures, voice communications, voice/data integration, video-conferencing, imaging multimedia, and network development. In the lab, consideration, measure-ment, and evaluation of the attributes of various types of terminals and data formatting pro-mulgated by the EIA, ANSI, ITU, and IEEE for voice, data, image, video, etc., are studied, along with the impact of format on file sizes, buffer delays, throughput, and quality of results. 1 TCH Design. *Prerequisite:* EE 3301.

3311. SOLID-STATE DEVICES. This course introduces the physical principles of semiconductor devices and their practical implementation in electronic circuits. Topics include metal-semiconductor junctions, p-n junctions, bipolar junction transistors, field-effect transistors, integrated circuits, and light emitting diodes. 1 TCH Design. *Prerequisites:* CHEM 1303 and EE 2352.

3315. OPTOELECTRONICS. This course introduces the student to the field of optoelectronics, the devices that form the foundation of optical communication and optical computing systems. Topics include optical propagation including plane waves; polarization; transmission and reflection of light; geometric optics; optical waveguides and fibers; optical modulation and beam steering with electro-optic, magneto-optic, and acousto-optic devices; optical sources such as lasers and light-emitting diodes; and optical detectors.

3322. ELECTRONIC CIRCUITS II. This course provides an introduction to the analysis and design of analog circuits containing bipolar and/or field effect transistors. Topics include small and large signal models, amplifier biasing, and amplifier small signal characteristics including gain, frequency response, and feedback. Students utilize computer circuit simulation (SPICE) for circuit analysis. 1.5 TCH Design. *Prerequisites:* EE 2322 and 2352.

3330. ELECTROMAGNETIC FIELDS AND WAVES. Vector analysis applied to static electric and magnetic fields, development of Maxwell's equations, elementary boundary-value problems, and determi-nation of capacity and inductance. Introduction to time-varying fields, plane waves, and transmis-sion lines. 1 TCH Design. *Prerequisites:* EE 2322 and 2352.

3360. STATISTICAL METHODS IN ELECTRICAL ENGINEERING. This course is an introduction to probability, elementary statistics, and random processes. Topics include fundmental 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. *Prerequisite:* EE 2370.

3362. ENERGY SYSTEMS. Fundamentals of electric machinery and electromechanical energy conversion. Topics include three phase circuits, magnetic circuits, transformers, and various kinds of AC and DC generators and motors. 1.5 TCH Design. *Prerequisite:* EE 2352.

3365. OPTOELECTRONICS. This course introduces the student to the field of optoelectronics. These devices form the foundation of optical communication and optical computing systems. Topics covered include optical propagation including plane waves; polarization; transmission and reflection of light; geometric optics; optical waveguides and fibers; optical modulation and beam steering with electro-optic, magneto-optic, and acousto-optic devices; optical sources such as lasers and light-emitting diodes; and optical detectors. *Prerequisite:* EE 2352.

3370. MATHEMATICS OF SIGNAL AND SYSTEMS ANALYSIS. A study of advanced level analysis techniques for continuous and discrete-time signals and systems using Fourier methods, and Z-transform techniques. Introduction to discrete Fourier transform and applications. 0.5 TCH Design. *Prerequisite:* EE 2352.

3372. INTRODUCTION TO SIGNAL PROCESSING. This course introduces students to the basics of digital signal processing. Topics include the design of FIR and IIR filters, Fourier and model-based spectral estimation, sampling rate conversion, applications of minimum mean-square estimation to signal estimation, and filtering. There is a heavy emphasis on MATLAB experi-mentation with real-world signals. *Prerequisite:* EE 2370, 2170.

3373. COMMUNICATION SYSTEMS. This course introduces students to the analysis and design of analog and digital communication systems. Topics include AM/FM modulation, pulse code modulation, communications over noisy channels, optimum digital receivers, digital modula-tion schemes, source coding, and channel capacity. *Prerequisite:* EE 2370, 2170, and 3360.

3381. MICROPROCESSORS. An introduction to microprocessors and microcomputers. The Motorola 68HC11 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. 1 TCH Design. *Prerequisite:* CSE 1317 or knowledge of computer programming with a high-level language.

4(1-3)90. SENIOR PROJECT.

4173. EE LABORATORY: WIRELESS MODEM LABORATORY. This course exposes students to a wide variety of real-world experiences in wireless communications. Lab exercises involve the development and testing of various propagation models, digital signaling schemes, and receiver structures through mobile software modems. Students also evaluate the effects of equalization on ISI channels, and source and channel coding on the efficiency and reliability of data transmission. *Prerequisite:* EE 3373. *Corequisite:* EE 4373.

4301. TELECOMMUNICATIONS SENIOR DESIGN I. Areas covered in this course will be tailored to the student's area of interest. This course is intended for seniors in Telecommunications Systems and Telecommunications Engineering. The design project segment of the course involves choosing from available senior projects in telecommuications. Depending on the specifics of the project, each student will design, construct, and test a solution and submit a formal report. 3 TCH Design. *Prerequisite:* Senior standing.

4302. TELECOMMUNICATIONS SENIOR DESIGN II. Areas covered in this course will be tailored to the student's area of interest. The design project segment of the course involves choosing from available senior projects in telecommunications. Depending on the specifics of the project, each student will design, construct, and test a solution and submit a formal report. 3 TCH Design. *Prerequisite:* EE 4302.

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. 3 TCH Design. *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 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. 3 TCH Design. *Prerequisiste:* EE 4311.

4372. ADVANCED TOPICS IN SIGNAL PROCESSING. This course examines a number of advanced topics in digital signal processing, covering a broad array of modern applications including interference cancellation, equalization, system identification, speech coding and enhancement, beamforming, image reconstruction, and video compression. *Prerequisite:* EE 3372.

4373. ADVANCED TOPICS IN WIRELESS COMMUNICATIONS. This course covers a variety of advanced topics in wireless, cellular, and personal communications. Specific topics include wireless architectures, CDMA and other multiuser communication schemes, DSL and FDM, cellular system design, equalization techniques, diversity techniques, and signal compression. *Prerequisite:* EE 3373.

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 TCH, which ranges from 1 to 3. The last digit ranges from 0 to 9 and represents courses with different topics.

5176. NETWORK SIMULATION LAB. This is an 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.

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 antennas, modems and interfaces, and digital transmission systems. T1 carriers, digital microwave, satellites, fiber optics and SONET, and Integrated Services Digital Networks. 0.5 TCH Design.

5302. Telecommunications Management and Regulation. The managerial sequel to EE 5301, Introduction to Telecommunications. It 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 it operates in today through the study of current events, articles, and recent state and federal legislation. *Prerequisite:* EE 5301 or experience in the telecommunications industry.

5303. Fiber Optic Telecommunications. This is an introductory course designed to familiarize students with practical concepts involved in optical fiber communications systems. Basic optical principles are reviewed. Dielectric slab-waveguides, fiber waveguides, and integrated optics devices are discussed. The major components of a fiber communications link, including optical sources, detectors, and fibers, are covered. 0.5 TCH Design.

5305. Object-Oriented Management Systems. Principles and practice of C++ programming. Object architectures. Principles, similarities and differences between SNMP, SNMPv2, and CMIP. Development of objects, management information blocks (MIBs), managers, and agents. Design requirements and development of SNMP applications for advanced intelligent networks and network simulation. 1 TCH Design. *Prerequisites:* CSE 2341 and EE 3302.

5310. Introduction to Semiconductors. A study of 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 process. 0.5 TCH Design.

5312. Semiconductor Processing Laboratory. This is a laboratory-oriented elective course for senior and first-year graduate students, and will provide an overview of integrated circuit process technology. For both, a bipolar and MOS process, SUPREM, and other CAD tools will be used for process modeling. The laboratory projects will include photolithography, doping, and metallization, as well as scanning electron microscopy and characterization. 2 TCH Design. *Prerequisite:* EE 3311 or equivalent.

5314 (ME 5314). Introduction to Micromechanical Systems (MEMS) and Devices. This course develops the basics for microlectromechanical 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.

5315. Superconductive Devices. An introduction to superconductivity and its applications. Topics include the phenomena of superconductivity, superconductive magnets and energy storage, transmission lines, paired-electron and "normal" electron tunneling, the D.C. and A.C. Josephson effects, magnetic screening, the Josephson equations, junction current-voltage characteristics, and applications of superconductive devices as voltmeters, magnetometers, and digital circuits, and in the generation, mixing, and detection of microwaves. 1 TCH Design. *Prerequisites:* EE 3330 and 3311.

5321. Semiconductor Devices and Circuits. A study of the basics of analog electronic circuits. Topics include relevant characteristics of BJT and FET transistor characteristics, DC biasing, small-signal models, single- and multistage electronic amplifiers, amplifiers with feedback, and frequency response of electronic amplifiers. Both single- and two-power-supply amplifiers are considered, with emphasis on amplifiers based on the differential amplifier stage. 1 TCH Design. *Prerequisite:* EE 3322.

5330. Electromagnetics: Guided Waves. Application of Maxwell's equations to guided waves. Transmission lines, and plane wave propagation and reflection. Hollow waveguides and dielectric waveguides. Fiber optics. Cavity and dielectric resonators. 1 TCH Design. *Prerequisite:* EE 3330.

5332. Electromagnetics: Radiation and Antennas. Polarization, reflection, refraction, and diffraction of EM waves. Dipole, loop, and slot/reflector antennas. Array analysis and synthesis. Self and mutual impedance. Radiation resistance. 1 TCH Design. *Prerequisite:* EE 3330.

5340. Introduction to Biomedical Engineering. Introductory course on the application of engineering principles to solving problems in medicine and biomedical research. Topics include measurement and diagnostic support instrumentation, computers in medicine, and medical imaging. Lab demonstrations involve the noninvasive measurement and analysis of a variety of physiological signals including the electroencephalogram, electrocardiogram, electromyogram, and phonecardiogram. For pre-med students interested in learning the operating principles of clinical instrumentation systems. 0.5 TCH Design.

5345. Biomedical Instrumentation. This course looks at the design and realization of biomedical instrumentation systems. Topics covered include the design of electrophysiological OP AMP-based amplifiers and filters, microprocessor-based data acquisition and graphics display systems, fundamentals and practical aspects of digital filtering, the FFT, medical imaging, and patient isolation and safety. The course project involves the design and realization of a complete microprocessor-based electrophysiological data acquisition, display, and analysis system. 1.5 TCH Design.

5356. VLSI Design and Lab. Laboratory-oriented course for senior and master 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. 2.5 TCH Design. *Prerequisites:* EE 3311 and 3380.

5357. CAE Tools for Structured Digital Design. This course 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. 2.5 TCH Design. *Prerequisites:* EE 2381 or permission of instructor.

5360. Control Systems I. Feedback control of linear continuous systems in the time and frequency domains. Topics include plant representation, frequency response, stability, root locus, linear-state variable feedback, and design of compensators. 1.5 TCH Design. *Prerequisite:* EE 3370.

5362 (ME 5302). Systems Analysis. State-space representation of continuous and discrete-time systems, controllability, observability, and minimal representations; linear-state variable feedback, observers, and quadratic regulator theory. 0.5 TCH Design. *Prerequisite:* EE 3370.

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. 1 TCH Design. *Prerequisite:* EE 3370.

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 two-dimensional filters. *Prerequisite:* EE 3372.

5372. Digital Signal Processing. Classification and characterization of discrete-time systems, z-transforms and its application, discrete Fourier transform, Fast Fourier transform, and digital filter design. 0.5 TCH Design. *Prerequisite:* EE 3370.

5373. Digital Signal Processing Laboratory. Digital signal processors (DSP's) 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 TMS320C50, 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.

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:* Permission of instructor.

5376. INTRODUCTION TO COMMUNICATION NETWORKS. This is an introductory course that surveys basic topics in communication networks with an emphasis on layered protocols and their design. Topics include OSI protocol reference model, data link protocols, local area networks, routing, congestion control, network management, security, and transport layer protocols. Network technologies include telephony, cellular, Ethernet, Internet protocol (IP), TCP, and ATM. Assignments may include lab exercises involving computer simulations.

5380. LOGIC DESIGN AND IMPLEMENTATION. The course covers the use of programmable logic devices (PLDs) for design and implementation of digital systems. Design and implementation using programmable read-only memories, programmable gate arrays, programmable logic sequencers, programmable array logic, and programmable generic array logic are discussed. The Altera MAX+plusII CAE tools will be used to model, simulate, and implement a design using modern PLD devices. 2.5 TCH Design. *Prerequisites:* EE 2381, EE 3381, or CSE 2340.

5381. DIGITAL COMPUTER DESIGN. Emphasizes design of digital systems and register transfer. Design conventions, addressing modes, interrupts, input-output, channel organization, high-speed arithmetic, hardwired and microprogrammed control. Central processor organization design and memory organization. 1 TCH Design. *Prerequisite:* EE 2381. Recommended but not required: EE 5357 or experience with hardware description language.

5385. MICROPROCESSORS IN DIGITAL DESIGN. This course is intended to help prepare the digital design engineer for utilization of microprocessors as programmable logic components in digital systems design. Topics include: fundamentals of both hardware and software engineering and their interrelationship with the microprocessor; capabilities and limitations of the Motorola 68000 microprocessor family; use of hardware/software development systems; assembly language programming for the 68000; input-output interfacing; and concepts involved in real-time applications. Also, features of the 68030 will be covered. 2 TCH Design. *Prerequisites:* EE 2381 and assembly language programming.

MECHANICAL ENGINEERING

Professor JOHNSON, *Interim Chair*

Professors: HOLMAN, HÜRMÜZLÜ, KOVACEVIC, MOHRAZ, PACKMAN, RAAD; *Associate Professors:* LAGE, LOVAS, SMITH, WATSON; *Senior Lecturer:* HAPPAWANA; *Adjunct Faculty:* BAUGHN, CASSIDY, GANNAWAY, GUEST, LEE, MCMAHON, MULARKEY, PIPINICH, PRICE, STRACENER, WITZKE; *Emeritus Professors:* BALLEISEN, C. SMITH, WEYNAND.

Mechanical engineering is a diverse field. Mechanical engineers determine solutions to problems in manufacturing, energy production and distribution, space exploration, construction, robotics, automation, and all aspects of transportation. Mechanical engineers engage in research, development, design, testing, manufacturing, operation, and maintenance of a variety of products and facilities that include automobiles, heavy machinery, aircraft, ships, space shuttles, fossil fuel and nuclear power plants, medical instrumentation, artificial organs, and manufacturing plants.

The department has a long tradition of offering an excellent engineering education that not only prepares one with a solid background in fundamentals of science and engineering, but also provides a diversified knowledge of design and practice. The mechanical engineering program incorporates, in addition to a strong liberal arts component, computers and laboratory experience throughout the curriculum. In the senior year, the students take a design project course in which teams of three or four students work with industrial sponsors and mentors on a practical design project. Undergraduate students are encouraged to participate in research projects. A cooperative education program (Co-op) is available. For further information on the Co-op Program, see "Cooperative Education" at the beginning of this section.

The program prepares students for tackling the challenging technological problems that confront society. The students also are prepared for graduate study in engineering or in other professional fields such as business, medicine, and law. Many recent graduates have gained employment as consulting engineers for major financial, banking, and real estate companies.

The department faculty is committed to excellence in undergraduate teaching. 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 Machines and Society, and Information Technology and Society.

The Department offers the following degrees:

- Bachelor of Science in Mechanical Engineering
- Bachelor of Science in Mechanical Engineering with a Pre-Medical or Biomedical Specialization
- Bachelor of Science in Mechanical Engineering with an Environmental Specialization
- Bachelor of Science in Mechanical Engineering with a Manufacturing Specialization
- Master of Science in Mechanical Engineering
- Master of Science in Manufacturing Systems Management
- Doctor of Philosophy in Mechanical Engineering

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

DEPARTMENTAL FACILITIES

The instructional and research laboratories in the department include these:

MECHANICS OF MATERIALS LABORATORY. This laboratory is equipped for instruction and research on the behaviors of materials under various loading conditions such as fatigue, impact, hardness, creep, tension, compression, and flexure.

SYSTEMS, MEASUREMENT, AND CONTROL LABORATORY. Equipped for instruction in the design and analysis of analog and digital instrumentation and control systems. Modern measurement and instrumentation equipment is used for experimental control engineering, system identification, harmonic analysis, simulation, and real-time control applications. Equipment also exists for microprocessor interfacing for control and instrumentation.

THERMAL AND FLUIDS LABORATORY. Equipment in this laboratory is used for performing experiments in heat transfer, thermodynamics, and fluid mechanics. Fundamental topics, analyzed experimentally, include friction in pipe flow, Bernoulli's equation, drag force around surfaces, centrifugal pump, internal combustion engine, refrigeration/heat pump systems, vortex tube, forced and natural convection cooling, air-water heat exchangers, interferometric visualization, laser radiation, heating, and lumped-capacity. State-of-the-art systems consisting of Apple Macintosh microcomputers, MacADIOS II Nubus boards, and LabView software with MacAdios Turbo Drivers support automatic control and data acquisition of several experiments.

COMPUTATIONAL/DESIGN LABORATORY. Dedicated computational facilities that include personal computers and high-resolution color X-Terminals, all tied to a local area network that allows high-speed communication with the school's and University's computers as well as with off-campus systems via NSFNet. SEAS' shared computational facilities include DEC servers, DEC workstations, and a 20-processor sequent parallel processing computer. Educational software includes Parametric Technologies Pro-Engineer CAD system, ANSYS structural analysis package, and Fluent CFD systems.

GRAPHICS LABORATORY. Used primarily for first-year graphics, the facility is available for upper-class students working on design projects. A special design projects library is located adjacent to the drafting room.

APPLIED MACHINE VISION LABORATORY. Latest technologies in image sensing, image acquisition, and image processing are integrated into systems to provide direct solutions for manufacturing industry problems. The laboratory is equipped with an ultra-high-shutter-speed camera assisted with pulsating nitrogen lasers, a high-frame-rate CCD camera, a three-dimensional machine vision system based on the structured-light SyncroVision camera, and three high-speed high-power image acquisition and processing systems.

HIGH-POWER LASER PROCESSING LABORATORY. This laboratory will be the only place in the Dallas Metroplex area where researchers, engineers, and students can work and get first-hand experience in the application of high-energy light to process different types of materials. A focused laser can melt, vaporize, or change the surface material properties of metallic materials of manufacturing technology, ranging from primary forming, cutting, drilling, joining, coating, and material property modification. The laboratory is equipped with a high-power MultiWave Nd:YAG laser with a power of 1000 watts in CW mode and 2500 watts in pulsating mode, a three-axis CNC positioning system, and a powerful data acquisition system for control and diagnostics.

SOLID FREEFORM FABRICATION LABORATORY. The field of rapid prototyping by Solid Freeform Fabrication is a relatively recent by-product of the computer-integrated manufacturing revolution. SFF processes are additive in nature, in that three-dimensional CAD geometry is fabricated by successively layering or adding two-dimensional slices of the solid. In this laboratory, high-power laser and welding processes are used to make structurally sound metallic functional parts, molds, and dies.

SUBMICRON ELECTRO-THERMAL SCIENCES LABORATORY. Research laboratory dedicated to the experimental and computational modeling of submicron integrated circuits.

SYSTEMS LABORATORY. Equipped for computational and experimental research in biomechanics, dynamics, and control.

WELDING R&D LABORATORY. The mission of this laboratory is to promote high-quality research and technological innovations in arc and plasma welding, to assist industry in implementing intelligent controllers for welding processes, and to provide graduate and undergraduate education in metal joining technology. The facility is equipped with three fully computerized welding cells (for gas tungsten arc welding, gas metal arc welding, and plasma arc welding).

CURRICULUM IN MECHANICAL ENGINEERING

MECHANICAL ENGINEERING is a broad curriculum, as evidenced by the range of job opportunities in government and industry including automotive, aerospace, chemical, petroleum, production, building construction, instrumentation, computer, machinery, nuclear energy, and electronics. The mechanical engineer is concerned with creation, research, design, analysis, production, and marketing of devices for providing and using energy and materials. Areas of specialization include the following:

SOLID MECHANICS is 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 SCIENCE 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; flow-through compressors, turbines, and pumps; flow around an airplane or missile; and so on. Fluid science interacts with solid mechanics in the practice of mechanical engineering because the fluid flow is generally bounded by solid surfaces. Fluid science is also an element in the synthesis of a design.

THERMAL SCIENCE is concerned with the thermal behavior of all materials — solid, liquid, and gaseous. The subject is divided into three important branches; thermodynamics, energy conversion, and heat transfer. Thermodynamics is the study of the response of a material when heat and/or work is supplied to it from its environment. Energy conversion is a study of the transformation of one form of energy to another, such as the conversion of thermal energy to mechanical energy in a gas turbine; the transformation of chemical energy to thermal and mechanical energy in the combustion chamber of a rocket engine; and 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 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 is the process by which real-world 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 a particular branch of engineering and deals with all elements of science, mathematics, and engineering.

The curriculum in mechanical engineering is accredited by the Accreditation Board for Engineering and Technology (ABET).

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

Curriculum Requirements

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

Term Credit Hours	*Courses*
124	Minimum total required.
21	ENGL 1301, 1302, Perspectives and Cultural Formations courses.
18	Mathematics: MATH 1337, 1338, 2339, 2343, and two advanced electives at the 3000 level or higher. One elective can be a statistics course, such as STAT 4340 (CSE 4340) or STAT 5340 (CSE 5370).
12	Sciences: *Physics* 1303, 1304, 1105, and 1106; *Chemistry* 1303 and 1113.
59	Engineering Science and Mechanical Engineering: ME 1302, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3360, 3370, 4360, 4160, 4338, 4370, 4380, and 4381; EE 1381 and 2350; CSE 1341.
12	Advanced Major Electives: Must be taken from selected 3000- or higher-level ME courses with the approval of the student's faculty adviser and department chair. Three TCH may be allowed from non-ME courses with prior approval of the student's adviser and department chair.
2	CHOICES I and II.

Any deviation from the ME curriculum requires approval of a petition submitted by the student to the ME 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 a 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:

Term Credit Hours	*Courses*
130	Minimum total required.
21	ENGL 1301, 1302 or First-Year Seminar, Perspectives, and Cultural Formations.
27	Mathematics: MATH 1337, 1338, 2339, 2343, 3315, 3337, STAT 4340/CSE 4340 or STAT 5340/CSE 5370, plus two advanced electives as defined in the description of the mathematics major.
12	Sciences: PHYS 1303, 1304, 1105, 1106; CHEM 1303 and 1113.
59	Engineering Science and Mechanical Engineering: ME 1302, 2310, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3360, 3370, 4360, 4160, 4338, 4370, 4380, 4381; EE 1381; and CSE 1341.

9	Advanced Major Electives: Must be taken from selected ME courses at the 3000 level or higher with the approval of the student's ME adviser. (One elective must be chosen from ME 5320, ME 5322, or ME 5336/MATH 5336.)
2	CHOICES I and II.

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 degree of Bachelor of Science in Mechanical Engineering and Bachelor of Science in Physics are as follows:

Term Credit Hours	*Courses*
129	Minimum total required.
21	ENGL 1301, 1302, Perspectives and Cultural Formations courses.
15	Mathematics: MATH 1337, 1338, 2339, 2343, and one advanced MATH elective.
38	Sciences: *Physics* 1303, 1304, 3305, 3344, 3345, 3374, 4221, 4392, 5382, 5383, and two advanced Physics electives; *Chemistry* 1303.
53	Engineering Science and Mechanical Engineering: ME 1302, 2310, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3360, 3370, 4360, 4160, 4338, 4370, 4380, 4381; EE 1381; and CSE 1341.
2	CHOICES I and II.

Any deviation from the ME and/or PHYS 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.

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 the three important areas of pre-medical or biomedical engineering, environmental engineering, and manufacturing. 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 (Pre-Medical or Biomedical Specialization)

The Mechanical Engineering Department offers a B.S.M.E. degree with a specialization in pre-medical or biomedical engineering. This program enables students to satisfy the pre-medical or pre-dental 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 degree in Mechanical Engineering with Pre-Medical or Biomedical specialization are as follows:

Term Credit Hours	*Courses*
129	Minimum total required.
21	ENGL 1301, 1302, Perspectives and Cultural Formations courses.
12	Mathematics: MATH 1337, 1338, 2339, 2343.
36	Sciences: *Biology* 1401, 1402, 3304, and 3306; *Chemistry* 1403, 1404, 3371, 3372, 3117, and 3118; *Physics* 1303, 1304. *
55	Engineering Science and Mechanical Engineering: ME 1302, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3360, 3370, 4338, 4370, 4380, 4381; EE 1381, 2350; CSE 1341.
3	Advanced Major Elective: May be selected from 3000-level or higher-level ME courses or from biomedical engineering courses ME 5332, EE 5340, or EE 5345.
2	CHOICES I and II.

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* It is recommended that students who plan to attend medical school also take PHYS 1105 and 1106.

Any deviation from the ME curriculum requires approval of a petition submitted by the student to the ME 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
(Environmental Specialization)

This specialization enables students to select five Environmental Engineering major electives. For more information and 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 Environmental Engineering specialization are as follows:

Term Credit Hours	*Courses*
124	Minimum total required.
21	ENGL 1301, 1302, Perspectives and Cultural Formations courses.
18	Mathematics: MATH 1337, 1338, 2339, 2343, and two advanced MATH electives at the 3000 level or higher. One of these electives can be a statistics course, such as STAT 4340 (CSE 4340) or STAT 5340 (CSE 5370).
12	Sciences: *Physics* 1303 and 1105; *Chemistry* 1303, 1304, 1113, and 1114.
56	Engineering Science and Mechanical Engineering: ME 1302, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3360, 4360, 4160, 4338, 4370, 4380, and 4381; EE 1381 and 2350; and CSE 1341.
15	Environmental Engineering Major Electives: ME 3346; 5313; 5315 or 5316; 5317 or 5318; and one other approved elective.
2	CHOICES I and II.

Any deviation from the ME curriculum requires approval of a petition submitted by the student to the ME 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
(Manufacturing Specialization)

This specialization enables students to select four Manufacturing 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 Engineering specialization are:

Term Credit Hours	*Courses*
124	Minimum total required.
21	ENGL 1301, 1302; Perspectives and Cultural Formations courses.
18	Mathematics: MATH 1337, 1338, 2339, 2343, and two advanced MATH electives at the 3000 level or higher. One of the electives can be a statistics course such as STAT 4340 (CSE 4340) or STAT 5340 (CSE 5370).
12	Sciences: *Physics* 1303, 1304, 1105, and 1106; *Chemistry* 1303 and 1113.
59	Engineering Science and Mechanical Engineering: ME 1302, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3360, 3370, 4338, 4360, 4160, 4370 4380, and 4381; EE 1381 and 2350; CSE 1341.
12	Manufacturing Major Electives: Students will select, with the approval of their adviser, four courses from the following list: ME 5350, 5351, 5352, 5353, 5354, 5355, 5356, 5357, 5358, 5372, and 5376.
2	CHOICES I and II.

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

MINOR IN MECHANICAL ENGINEERING

For information on a minor in mechanical engineering, the student should consult the department. A total of 15 term hours in mechanical engineering courses is required. One approved set of courses that provides a broad introduction to mechanical engineering is:

ME 1302	Introduction to Engineering
ME 1303	Energy, Technology, and the Environment *or*
ME 1301	Machines and Society
ME 2310	Statics
ME 3340	Engineering Materials
ME 3370	Manufacturing Processes

Other mechanical engineering courses may be substituted with the approval of the department.

THE COURSES (ME)

1301. MACHINES AND SOCIETY. Introduces engineering systems to non-engineering students. The course is divided into four parts: 1) What is engineering, and what do engineers do? In particular, what do mechanical engineers do? Historical perspective on engineering design, principles of design engineering, and energy conversion processes. 2) Engineered products. What do mechanical engineers produce? The basic principles of converting science to technology. 3) The development of technology for society and humanity. 4) The laboratory and workshop experience, including computer animation and simulation.

1302. Introduction to Engineering. Traditional engineering and drawing; hands-on computer-aided graphics; design philosophy including safety, ethics, and products liability; special topics presented by practicing professionals; and history of engineering. 1 TCH of design.

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.

1304. Control of Environmental Pollution. History and philosophy of environmental pollution awareness and control; interrelationship of population dynamics, waste generation, and resource availability; in-depth examination of air and water pollution and control technology; hazardous and solid waste generation and control; and societal issues and environmental strategies. Includes laboratory component.

1305. Information Technology and Society. A comprehensive survey of information technologies and the growing interconnectivity between them as currently utilized throughout society. The student will acquire portable IT skills in the use of word processing, spreadsheets, presentation tools, graphics applications, and the Internet that will prepare him or her 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. Offered parallel to ME 2331. *Prerequisite:* MATH 1337 (Calculus I), sophomore standing.

2140. Mechanics of Materials Laboratory. Experiments in mechanics of deformable bodies, to complement ME 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, effect of stress concentrators. Offered parallel to ME 2340. *Prerequisite:* MATH 2310 or equivalent.

2142. Fluid Mechanics Laboratory. One three-hour laboratory session per week. Credit: 1. Experiments in fluid friction, pumps, boundary layers, and other flow devices to complement lecture material of ME 2342. Offered parallel to ME 2342. *Prerequisite:* ME 2320.

2310. Statics. Equilibrium of force systems; computations of reactions and internal forces; determinations of centroids and moments of inertia; 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. Fundamentals of Thermal Science (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. *Prerequisite:* MATH 1337.

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. 1 TCH Design. *Prerequisite:* ME 2310.

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:* ME 2320 and MATH 1338.

3132. Heat Transfer Laboratory. One three-hour laboratory session per week. Credit: 1. Experiments in conduction, convection, and radiation to complement lecture material of ME 3332 – Heat and Mass Transfer. Offered parallel to 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. *Prerequisite:* MATH 2343.

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 in lecture and laboratory. *Corequisite:* ME 2310 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.

3346. ENVIRONMENTAL ENGINEERING LABORATORY. Instrumental and statistical methods used for characterization of water and air quality. Introduction to water treatment methods and reactor dynamics. *Prerequisite:* CHEM 1303 and Ordinary Differential Equations.

3350. STRUCTURAL ENGINEERING I. Analysis of statically determinate structural systems; computation of reactions, shears, moments, and deflections of beams, trusses, and frames. Design of metal structures for axial, flexure, and shear. Use of computers in analysis and design. *Prerequisite:* ME 2340.

3360. SYSTEM DYNAMICS. Introduction to the modeling and analysis of simple physical systems. Idealized physical elements; through and across variables; elemental equations for mechanical, thermal, fluid, and electrical systems; linear graphs; modeling and analysis of simple first- and second-order systems. Mixed-system models: transducers. Generalized impedance and transfer function models. 1 TCH Design. *Prerequisites:* ME 2320, MATH 2343.

3370. MANUFACTURING PROCESSES. Course presents an overview of the processes used to produce finished parts: casting and forming processes, powder metallurgy, machining, joining processes, gauging. Includes field trips to local industry and reports. 1 TCH Design. *Prerequisite:* ME 3340.

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. 1 TCH Design. *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 is included. 3 TCH Design. *Prerequisites:* ME 2331, 2342, and 3332.

4350. STRUCTURAL ENGINEERING II. Analysis of statically indeterminate structures. Design of metal structures for torsion and lateral buckling. Design of continuous beams and frames. Design of connections in metal structures. *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 modelling 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. 1 TCH Design. *Prerequisite:* ME 3360.

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. *Prerequisite:* ME 2340. *Corequisite:* ME 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. Non-technical considerations in design, including patents, ethics, aesthetics, safety, and economics are investigated. 3 TCH Design. *Prerequisite:* ME 4370.

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. *Prerequisite:* ME 4380.

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 covered include state representation of linear systems, controllability, observability, and minimal representation, linear state variable feedback, observers, and quadratic regulator theory. 1 TCH Design. *Prerequisite:* ME 4360/EE 3370.

5313 (SSH 7313). ENVIRONMENTAL CHEMISTRY AND BIOLOGY. Chemical and biochemical processes; controlling fate and transport of hazardous materials with emphasis on chemical equilibria; chemical thermodynamics; acid-base equilibria; precipitation and dissolution; oxidation-reduction processes; environmental transformations of organic materials; introductory taxonomy; microbial growth and kinetics; energy transfer; and microbial ecosystems.

5315 (SSH 8321). TREATMENT TECHNOLOGY I – PHYSICAL AND CHEMICAL. Unit processes for treatment of hazardous contaminants with focus on liquid-phase systems; contaminant classification; process dynamics; phase and species transformation and processes; neutralization, chemical oxidation, and volatilization; particulate separation and concentration; coagulation and flocculation, sedimentation and flotation, and filtration; soil washing, soil vapor extraction, and solute separation and concentration; adsorption, ion exchange, membrane processes; ultimate destruction and disposal.

5316 (SSH 8322). TREATMENT TECHNOLOGY II – BIOLOGICAL AND INCINERATION. Aerobic systems, aerated lagoons; trickling filters; biological contractors; anaerobic systems; sludge handling; incineration chemistry, incineration thermodynamics, incineration types; *in situ* vitrification; *in situ* bio-treatment; sampling techniques; pollution abatement equipment; case studies.

5317 (SSH 8332). GROUND WATER HYDROLOGY AND CONTAMINATION. Ground water hydrology; aquifer and well hydraulics; flow equations and models; implications for landfill design; sources and nature of ground water contaminants; monitoring and analysis; contaminant fate and transport; transport model for hazardous substances; ground water pollution control measures; containment and treatment; ground water quality management.

5318 (SSH 8334). FATE AND TRANSPORT OF CONTAMINANTS. Development and application of fate and transport models for hazardous substances with focus on water-sediment, water-soil, and water-air interfaces; material balance principle; mass transport and transformation processes; modeling of lakes and reservoirs; stream modeling; general flow case; ground water models; miltiphase and integrated modeling approaches; and case studies.

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, temperature-dependent and environment-dependent mechanical properties. 2 TCH Design. *Prerequisites:* ME 2340 and ME 3340.

5320. INTERMEDIATE DYNAMICS. Kinematics and dynamics of particles and rigid bodies: kinematics, inertia properties. Kane's dynamical equations. Euler's equations of motion. D'Alembert's principle, Lagrange's equations of motion. *Prerequisite:* ME 2320 or equivalent.

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, causes of failure. 2 TCH Design. *Prerequisites:* ME 3340 and 4470.

5322. VIBRATIONS. Fundamentals of vibrations with application of simple machine and structural members. Harmonic motion, free and forced vibration, resonance, damping, isolation, and transmissibility. Single multiple and infinite degree-of-freedom systems. *Prerequisites:* ME 2320 and MATH 2343 or equivalent.

5323. INTRODUCTION TO FRACTURE MECHANICS. Linear elastic fracture mechanics, application of theory to design and evaluation of critical components: elastic stress intensity calculations, plane strain fracture toughness, plane stress and transitional behavior, crack opening displacements, fracture resistance, fatigue crack propagation, transition temperature approach to fracture control, microstructure of fracture, and fracture control programs. 2 TCH Design. *Prerequisite:* ME 2340.

5324. FATIGUE THEORY AND DESIGN. A senior-graduate course. Includes continuum, statistical, and fracture mechanics treatments of fatigue, stress concentrators, planning and analysis of probit, SNP and response tests, mechanisms of fatigue design, fail safe vs. safe life design, crack propagation. Emphasizes engineering design aspects of fatigue rather than theoretical mechanisms. 2 TCH Design. *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 over-steer and under-steer 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. Steady and unsteady state, special configurations, numerical and analytical solutions, and design are topics included.

5331. ADVANCED THERMODYNAMICS. Laws of thermodynamics, availability, irreversibility, real gases and mixtures, thermodynamic relations and generalized charts, combustion, chemical and phase equilibrium, and computational combustion. *Prerequisites:* ME 2331 and ME 3341 or equivalent.

5332. HEAT TRANSFER IN BIOMEDICAL SCIENCES. Fundamentals of heat transfer in medicine and biology. Biothermal properties. Thermal regulation processes. Biomedical heat transfer processes with applications in tissue laser radiation, freezing and thawing of biological materials, cryosurgery, and others. *Prerequisite:* ME 3332.

5333. TRANSPORT PHENOMENA IN POROUS MEDIA. Fundamental concepts of momentum, heat, and mass transport through porous materials. Flow regimes, their mathematical modeling, and implications on transport phenomena. Emphasis is placed on heat and mass transfer in fully saturated systems. Relevant industrial applications (e.g., oil recovery, chemical reactors, food processing and storage, microelectronics cooling, groundwater hydrology, bio-heat) are presented throughout the course.

5336 (MATH 5336). INTERMEDIATE FLUID DYNAMICS. Review of fundamental concepts of undergraduate fluid mechanics and introduction to advanced fluid dynamics, including irrotational flow, tensore notation, and the Navier-Stokes equations. *Prerequisite:* ME 2342 or equivalent.

5337. INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS: FUNDAMENTALS OF FINITE DIFFERENCE METHODS. Concepts of stability, convergence, accuracy, and consistency. Applications to linear and non-linear model partial differential equations. Curvilinear grid generation. Advanced topics in grid generation. Beam and Warming factored implicit technique. MacCormack techniques. Solution methods for the Reynolds equation of lubrication, the boundary layer equations, and the Navier-Stokes equations. *Prerequisites:* ME 2342 (or equivalent), and MATH 2343 (or equivalent), or permission of instructor.

5340. INTRODUCTION TO SOLID MECHANICS. The theories of failure, principal stress, and strain for solid bodies. An introduction to plate theory, elastic stability, energy methods, and theory of elasticity. Torsional analysis of non-circular sections. *Prerequisite:* ME 2340.

5341. Structural Properties of Solids. This course is 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 permission of instructor.

5350. Design for Manufactureability and Concurrent Engineering. The advantages of involving both manufacturing and engineering into the early design of products and processes effectively, and cost determination and assessment of processing alternatives at the early design/manufacturing interface. Designing for manufacturing processing and factory capabilities as a function of quality, price, performance, and productivity will be examined with emphasis on parts and process simplification, alternative methods, anticipated volumes, and automated assembly.

5351. Computer-Integrated Manufacturing Systems. Imparts the basic concepts and use of computer-integrated manufacturing. Topics include integration techniques for manufacturing islands of automation; process planning and the production process life cycle in relation to automated control systems; process design techniques for shop-floor control of multiple interacting processes; distributed network process control; real-time aspects; interface protocols and languages of shop-floor machinery; computational and data processing techniques for planning, design, production, and shipping; and methods of optimizing output quality, price, and productivity. Economic justification and the use of artificial intelligence with respect to planning and process control will be examined.

5352. Modern Manufacturing Methods and Systems. Highly successful manufacturing methods and systems will be examined. Topics include the evolution of manufacturing technology in the United States, mass manufacturing, integrated manufacturing, distribution and manufacturing automation, just-in-time systems, continuous improvement, Kaizen, poka yoke, and total quality management. Modern Japanese manufacturing techniques will be examined in depth. The underlying concepts and strategic benefits of flexibility, agility, time-based competition, and global manufacturing operation will be covered. The course will be presented from the perspective of the manufacturing manager.

5353. Manufacturing Management Practices. New organizational structures, paradigms, and leadership styles. Problem solving within the business context: manufacturing strategies for optimizing production processes across the enterprise. Measuring and reporting business performance. Investment decision making under conditions of risk and uncertainty. Intellectual property strategies, products liability and the legal environment. Contemporary practices, including self-directed work forces, competitive assessment, total productive maintenance, managerial and activity-based costing, and other topics.

5354. Total Quality Management in Manufacturing. An overall total quality management perspective for the design of quality management systems. Metrics for cycle time and defects, baselining and benchmarking, and House of Quality approaches are examined. Managing product quality from inception to deployment. Topics include acquiring and stabilizing new production processes, data collection and analysis for improvement, and decision making. Purchasing, process control, and reliability are covered in detail. Taguchi and poka-yoke and other practices are examined as tools for implementing TQM.

5355. Integrated Design and Manufacturing. Industrial performance is strongly correlated to success in integrating design and manufacturing. The inter-relationships between the total product realization cycle, product generation, and manufacturing are examined with the objective of improving industrial performance.

5356. Human Factors in Design and Manufacturing. A senior-graduate course dealing with human factors or ergonomics relating to designing for human use. The lectures cover the empirical and analytic aspects of design and manufacturing as affected by the need to accommodate human use and abilities. Included are topics on visual displays of static and dynamic information, text, graphics, symbols, codes, auditory tactual and olfactory displays, speech and nonverbal communications, physical work/materials handling, motor skills, and hand tool devices and controls. Workplace design, anthropometry, component arrangement in space, lighting, sound, climate, and motion will be covered. 1.5 TCH Design. *Prerequisite:* Senior or graduate standing, or permission of instructor. *Recommended:* Understanding of simple statistical analysis.

5357. Optimized Mechanical Design. 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.). Computer applications. 3 TCH Design. *Prerequisite:* ME 4370 or equivalent.

5358. Design of Electronic Packaging. 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. 2 TCH Design. *Prerequisites:* ME 2340 and 3332, or permission of instructor.

5361. Matrix Structural Analysis. A systematic approach to formulation of force and displacement method of analysis; representation of structures as assemblages of elements; computer solution of structural systems. *Prerequisite:* ME 3360 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.

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; introduction to systems with distributed mass and flexibility. *Prerequisites:* ME 5361 or equivalent, a course in different equations.

5365. Strategies for Manufacturing Firms. Examines the deveopment and implementation of strategies for product design and manufacturing that best supports the overall strategy of the firm. Topics include positioning the product and production system in the industry, location and capacity decision, implementing manufacturing technologies, facilities planning, vertical integration, logistics planning, and organizational culture. Case studies of manufacturing firms are used extensively.

5366. Manufacturing in a Global Era. This course examines goals and strategies for manufacturing operations in the multinational environment. Topics include decision making for decentralizing and setting up foreign manufacturing operations, marketing, sales and distribution strategies, R&D support, location and capacity decisions, implementing new manufacturing technologies, facilities planning and modernizations, vertical integration, outsourcing strategies, logistics planning and organizational cultures. Case studies of manufacturing firms are used.

5368. Project and Risk Management. Focuses on specific concepts, techniques and tools for managing projects successfully. Network planning techniques, resource allocation, models for multi-project scheduling, methods of controlling costs, determining schedules and performance parameters. The basics of risk management including hard analysis, risk analysis, risk control, and risk financing are covered. The focus of the course is to integrate risk assessment with managerial decision making. Examples and case studies are emphasized.

5369. Managing Technology and Innovation. In the face of rapid technological growth and innovation, a disciplined management approach is necessary to assure a reasonable expectation of success. The course examines the factors of proper selection, justification, and implementation of new technologies within the framework of consumer electronics, advanced materials, and emerging information capabilities, expert systems and machine tool industry. Topics include technological forecasting risk and uncertainty, and project management.

5371. Gas Dynamics and Design of Propulsion Systems. One-dimensional compressible flow, linearized two-dimensional flow method of characteristics, and oblique shocks. Design of air-breathing propulsion systems components: inlets, nozzles, compressors, turbines and combustors. Interactions with the external flow. 1 TCH Design. *Prerequisites:* ME 2342 and 3341.

5372. Introduction to CAD/CAM. Introduction to 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 drafting and analysis. Use of commercially available, computer-aided design systems. Development of special purpose interactive computer graphics programs. 2 TCH Design.

5376. ROBOTICS – INTRODUCTION TO COMPUTER-AIDED MANUFACTURING. Introduction to industrial robotics and numerically controlled machines. Economics of CAM. Applications of robotics in industry. Robot safety. Addition of senses and intelligence. Research in CAM. Flexible manufacturing cells and systems. Hands-on laboratory work with industrial robots and NC machines. Independent study and report on a specific robot application. 2 TCH Design. *Prerequisites:* CSE 1341, PHYS 1403, and MATH 2343 or equivalent.

5383. HEATING, VENTILATING, AND AIR CONDITIONING. Selection and design of basic refrigeration, air conditioning, and heating systems are treated. Load calculations, psychometrics, cooling coils, cooling towers, cryogenics, solar energy applications, and special topics are included. 1 TCH Design. *Prerequisites:* ME 2331 and 3332.

5386. CONVECTION HEAT TRANSFER. Advanced topics in forced convection heat transfer using analytical methods and boundary-layer analysis. Laminar and turbulent flow inside smooth tubes and over external surfaces. Convection processes in high-speed flows. *Prerequisite:* ME 3332 or equivalent.

5(1-4)90. UNDERGRADUATE SEMINAR. 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 chairman of the department in which the student expects to receive the degree. Variable credit of one to four term hours. Variable TCH Design.

5(1-4)91. 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.

ENVIRONMENTAL ENGINEERING AND SCIENCE

Professor VACROUX, *Acting Chair*

Associate Professors: FOREST, SMITH; *Senior Lecturers:* CHADBOURNE, DICKEY; *Adjunct Professor:* DAVIS; *Adjunct Associate Professors:* CARNEY, DUKE, RAUSCHER, SPITZBERG, STOKES; *Adjunct Assistant Professors:* ADAMS, EDLUND, LEGG, ZENG.

The disciplines that define environmental engineering have changed considerably since 1900, the begining of the field as a separately distinguishable discipline, initially concerned with local sanitary problems and the development of regional water supplies. The changes that have occurred during the past 25 years have far exceeded those of the previous seventy. Today, the field encompasses not only water and wastewater management, but hazardous and radioactive materials, solid waste minimization, treatment processes of pollutants, resource conservation and recovery, sustainable biological processes, and air pollution control.

In the future, as global industrialization continues to expand, traditional means of controlling pollution such as *end-of-pipe* approaches will provide few additional net benefits, since such methods simply shift the waste burden to other locations and media. Today, cost-effective approaches such as *pollution prevention* and *waste minimization* are being increasingly emphasized by industry. The considerable benefits these source-focused conservation approaches offer include reduced demand for materials and energy, lower expenses associated with waste management, and a much stronger competitive position. In addition, modern manufacturing practices are increasingly being directed toward producing *green* products, which are fabricated from recycled and natural products that are harmlessly degraded in the environment, reducing disposal costs further.

This program provides students with the skills and background to fully participate as designers and managers in this challenging, rapidly changing, and increasingly essential field. Two undergraduate degrees are offered: a Bachelor of Science in Environmental Engineering and a Bachelor of Science with a major in Environmental Science. Either course of study provides the student with a broad understanding of the scientific and engineering principles necessary for a fundamental knowledge of this field. The program prepares the student for professional practice or graduate study in the environmental disciplines and emphasizes the following areas: water and water resources, solid and hazardous waste, and atmospheric systems and air pollution. The concepts of waste minimization, pollution prevention, and management are integrated into the curriculum and linked to the design process as it is conducted in industry.

The curriculum of the B.S. degree in Environmental Engineering is consistent with ABET accreditation guidelines and with preparation for the Fundamentals of Engineering (FE) examination, the first step toward licensing as a Professional Engineer (P.E.). In their senior year, Environmental Engineering students are required to take two terms of design, in which teams of three or four students work closely on practical projects sponsored by industry.

The curriculum of the B.S. degree with a major in Environmental Science is designed to meet the professional goals of students whose environmental interests are broader. The program offers the student greater course flexibility with respect to the sciences and other electives. Omitted from this curriculum are several fundamental engineering and design courses that serve to prepare students for professional engineering licensing. Included, however, are three engineering courses that are judged to be necessary for the environmental science emphasis.

FACILITIES

THE ENVIRONMENTAL ENGINEERING LABORATORY has capabilities for assessing the quality parameters of water supplies and wastes, as well as the effectiveness of various water and waste-treatment procedures. The laboratory is equipped with several spectrophotometers, pH and other specific ion meters, incubating ovens, microscopes, furnaces, centrifuges, and dissolved oxygen meters. Other major equipment includes two spectrometers for low-level heavy metal analysis, two Hewlett-Packard gas chromatographs for low-level organic analysis, a Mettler titrator for chemical and acid/base surface analysis experiments, and a solvent delivery system for precise low-flow metering. Also available are several temperature-control baths and a tumbler for constant temperature studies.

BACHELOR OF SCIENCE IN ENVIRONMENTAL ENGINEERING

CURRICULUM REQUIREMENTS

Term Credit Hours	*Courses*
126	Minimum total required
23	Humanities, Social Sciences, and SMU required courses
15	Mathematics and Statistics: MATH 1337, 1338, 2339, 2343; STAT 4340
23	Sciences: *Biology:* BIOL 1401 *Chemistry:* CHEM 1113, 1114, 1303, 1304, 3117, 3371 *Geology:* GEOL 1301 or 1315 *Physics:* PHYS 1105, 1303
21	Engineering Science and Design: *Computer Science and Engineering:* CSE 1341 *Electrical Engineering:* EE 1381 *Mechanical Engineering:* ME 1302, 2310, 2331, 2340, 2342

32	Environmental Engineering and Design: *Environmental:* ENV 1301, 2304, 2421, 3323, 3331, 3341, 3451, 4354, 4380, 4381
6	Environmental Technical Electives (selected with adviser approval)
6	Additional Technical Electives

BACHELOR OF SCIENCE WITH A MAJOR IN ENVIRONMENTAL SCIENCE

Curriculum Requirements

Term Credit Hours	*Courses*
123	Minimum total required
29	Humanities, Social Sciences, and SMU required courses
15	Mathematics and Statistics: MATH 1337, 1338, 2339, 2343; STAT 4340
23	Sciences: *Biology:* BIOL 1401 *Chemistry:* CHEM 1113, 1114, 1303, 1304, 3117, 3371 *Geology:* GEOL 1301 or 1315 *Physics:* PHYS 1105, 1303
9	Engineering Science: *Computer Science and Engineering:* CSE 1341 *Mechanical Engineering:* ME 2331, 2342
26	Environmental Engineering: *Environmental:* ENV 1301, 2304, 2421, 3323, 3331, 3341, 3451, 4354
9	Environmental Technical Electives (selected with adviser approval)
12	Recommended Technical Electives (free electives)

THE COURSES

ENV 1301. Environment and Technology: Ecology and Ethics. Quantitative techniques for life-cycle analysis (LCA) of the environmental impact of materials extraction, processing, use, and recycling are presented. Economic analysis of materials processing, product development, and markets are examined. Students visit off-site manufacturing facilities. Case studies and LCA of common products and processes are presented.

ENV 2304. Introduction to Environmental Engineering and Science. Introduction to a scientific and engineering basis for analyzing and understanding various environmental problems. Although traditional materials in air and water pollution are examined, emphasis is given to topics such as hazardous waste, risk assessment, groundwater contamination, global climate change, stratospheric ozone depletion, and acid deposition. Limits to population and technology growth are examined in terms of resource consumption and population momentum. Where appropriate, pertinent environmental legislation is described, engineering models generated, and treatment technologies introduced. *Prerequisites:* MATH 1338, CHEM 1303.

ENV 2421. Aquatic Chemistry. The physical chemical properties that govern the behavior of aquatic systems such as lakes, oceans, rivers, estuaries, groundwaters, and wastewaters are examined. Topics include thermodynamics, kinetics, acids and bases, dissolved gases, interactions between solid phases and solutes, coordination, redox, and sorption. Emphasis is placed on quantitative study of model systems. Interactions between physical, chemical, and biological variables in natural waters are stressed. Lecture and three hours of laboratory. *Prerequisites:* MATH 1338, CHEM 1303.

ENV 3323. Water Resources Engineering. The hydrologic cycle and atmospheric processes including water and energy balance and radiation, precipitation, evaporation, and transpiration by vegetation are introduced. Groundwater flow and the hydraulics of wells are examined, as are routing of runoff and flood waters. The student is exposed to probabilistic analysis and extreme value theory for determination of flood hazard. Data analysis and the role of design in water resource engineering are emphasized. *Prerequisites:* ENV 2304, ME 2342.

ENV 3325. GROUND WATER 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:* MATH 2343, ME 2342.

ENV 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:* MATH 2343, CHEM 1304.

ENV 3331. INTRODUCTION TO AIR POLLUTION. The criteria for anticipating environmental problems with indoor air, plume dispersion, stationary combustion sources, acid rain, NO_x and SO_x emissions, and their control are examined using quantitative risk assessment models. Smog formation models are introduced. The nature of CO, HC, NO_x, and particulate emissions from internal combustion engines, as well as their control systems, are examined. An assessment of global warming problems is introduced, and strategies for control are reviewed. Stratospheric ozone and related atmospheric toxic substances are studied. *Prerequisite:* MATH 2343; *Corequisite:* CHEM 3371.

ENV 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:* ENV 2304 and 2421.

ENV 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 1401; *Corequisite:* CHEM 3371.

ENV 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:* ENV 2304.

ENV 3451. PRINCIPLES OF INDUSTRIAL HYGIENE AND ENVIRONMENTAL CONTROL. The recognition, evaluation, and control of health hazards in the working environment are presented. Principles of industrial toxicology, 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 industrial ventilation systems are introduced. Lecture and three hours of laboratory. *Prerequisite:* BIOL 1401.

ENV 4329. DESIGN OF WATER AND WASTEWATER SYSTEMS. The theory and design of systems for treating municipal wastewater are presented. Methods for characterizing wastewater properties are introduced. Physical, chemical, and biological processes, including primary treatment and suspended growth and fixed-film methods for secondary treatment are examined in detail, including reactor design and process kinetics. State-of-the-art processes including sludge and disposal methods are included. Field trip to local wastewater treatment plant. *Prerequisite:* ENV 4354.

ENV 4333. Atmospheric Chemistry. The principles that govern the chemical behavior of the terrestrial atmosphere are described. Chemical reactions and bio-geochemical cycles that control the abundance of trace species in the troposphere and stratosphere are introduced. Emphasis is placed on the potential damaging effects of human activity on the chemical balance of the atmosphere. Stratospheric ozone depletion, regional and local photochemical smog, and greenhouse gases are examined in detail. *Prerequisites:* CHEM 3371, ENV 3331.

ENV 4380. Environmental Engineering Design I. The industrial environment of designers – i.e., their responsibilities in commercial and professional context, theory, and practice – is examined. The nature of design problems, the constraints within which they exist, and the design tools available are presented. The integrated design process, iterative processes, user needs analysis, specifications, alternative solutions, and trade studies are examined. *Prerequisite:* Senior standing.

ENV 4381. Environmental Engineering Design II. Student design teams are responsible for completing a term-long environmental project for an industrial client. Personal and written communication skills and team aspects such as leadership, participation, and creative problem solving are stressed. Periodic design reports and reviews are prepared and presented. The completed project is assessed by both the client and faculty. *Prerequisite:* ENV 4380.

ENV 4354 (ME 4354). Environmental Engineering Principles and Processes. Introduction to biological, chemical, and physical principles and treatment strategies for removal of pollutants from water, gas, and solid waste streams. Environmental statistics and impact assessments. *Prerequisites:* Fluid Mechanics, General Chemistry, and Differential Equations.

SSH 5311. Environmental and Hazardous Waste Law. RCRA, CERCLA, and other acts; regulations and the regulatory framework; definitions; policy guidance vs. regulations; role of the states, municipalities, and the EPA; compliance issues; case studies.

SSH 5312. Risk Assessment and Health Effects. Introduction to toxicology as it relates to environmental and health effects of hazardous materials; toxicology methodology; risk management factors, including microbiological and socio-legal aspects; risk assessment and communication; emergency response; computer databases and access to risk analysis inventories.

SSH 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; microbial ecosystems.

SSH 5314. Sources and Nature of Hazardous Wastes. Designated criteria of hazardous waste; assessment of hazardous sites; underground storage tanks construction, installation and closure, soils management, financial assurance; injection wells, technology and construction, operation, plugging, pressure impacts, migration of contaminants, and monitoring.

SSH 5315. Integrated Waste Management. Integrated strategies for waste control with focus on municipal solid waste; municipal incineration; integrated waste reduction – source reduction, recycling, disposal, waste minimization, materials recovery, energy considerations; municipal solid waste landfill criteria; hazardous waste landfills; public and private landfills; McLommas landfill.

SSH 5333. Laboratory Methods in Environmental Engineering. The 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:* SSH 5313 (Environmental Chemistry) or two terms of undergraduate chemistry.

CENTER FOR SPECIAL STUDIES

The Special Studies designation is used to accommodate academic programs and courses that do not naturally fit within the departments of the School of Engineering and Applied Science. Included under this designation are courses designed to enable students who are not concentrating in engineering or applied science to learn about the characteristics, capabilities, and limitations of modern technology. Understanding of the machines and technical systems upon which contemporary society depends is of importance to students planning careers in business or the professions, or in the public sector.

THE COURSES

SS 1099, 2099, 3099, 4099, 5099. Engineering Internship. 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 other SMU courses except that no tuition is charged. Each course grade is determined by a written report by the student and from the scoring of the employer's evaluation form.

SST 3300. Technology and Public Policy. In this course, the effects of technology and public policy are studied by examining issues that involve business, engineering, social sciences, and international relations. Selected technological areas such as communications, energy, computers, and transportation are explored in detail to identify the problems that government and other institutions attempt to solve.

Army ROTC

Army ROTC (Reserve Officers Training Corps) is an on-campus program that offers college students the opportunity to graduate as officers and serve in the U.S. Army, the Army National Guard, or the U.S. Army Reserve. Scholarships are offered and are awarded on a competitive basis to the most outstanding students who apply. Each scholarship pays for college 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 participate in the Army ROTC on-campus program by registering at the same time and manner as they register for other SMU courses. The Army ROTC courses are listed under Special Studies.

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. Students who participate in the UTA Army ROTC program are responsible for their own travel and other physical arrangements. The courses are listed under Special Studies in the Schedule of Classes.

Army ROTC Special Series Studies Courses (ROTC)

Credit for any of these Military Science courses may not be used to satisfy any School of Engineering and Applied Science Degree Program requirements.

1180, 1181. Army ROTC Leadership Laboratory. A practical laboratory of applied leadership and skills. Student-planned, -organized, and -conducted training, oriented toward leadership development. Laboratory topics include marksmanship, small unit tactics, and multitiered programs focused on individual skill levels. All uniforms and equipment is provided without cost to the student. 1180/1181 must be taken by all scholarship and contracted cadets. This course is required for any student concurrently enrolled in other military science courses at the 1000 level or higher.

1143. Army ROTC Introduction to Leadership I. Provides introduction to basic military skills to include principles of emergency first aid and evacuation of casualties, map and compass reading, terrain association, and cross-country navigation. Principles of physical fitness training.

Introduction to military inspections. Concurrent enrollment in SSR 1180 is mandatory.

1144. Army ROTC Introduction to Leadership II. Designed to assist the student through the proper use of study habits and time management. Provides basic understanding of the Army, its organization, customs, and traditions. Concurrent enrollment in SSR 1181 is mandatory.

2180, 2181. Army ROTC Leadership Laboratory. A practical laboratory of applied leadership and skills. Student-planned, -organized, and -conducted training, oriented toward leadership development. Laboratory topics include marksmanship, small unit tactics, and multitiered programs focused on individual skill levels. All uniforms and equipment is provided without cost to the student. 2180/2181 must be taken by all scholarship and contracted cadets. This course is required for any student concurrently enrolled in other military science courses at the 2000 level or higher.

2232. Army ROTC Basic Leadership. Introduction to the principles of military leadership, to include corps or non-commissioned officers, the decision-making process, and military correspondence. Attention is also given to the skills of establishing a physical training program, and land navigation. Concurrent enrollment in SSR 2180 is mandatory.

2249. Army ROTC Evolution of Contemporary Military Strategy. A review of contemporary military conflicts. Selected battles from World War II, Korea, Vietnam, and the Yom Kippur War are examined for impact upon current U.S. military doctrine, strategy, and weapons systems. A scenario of imagined future conflict is also studied. All military science students must enroll in SSR 2181 concurrently with this course unless exception is given by the instructor.

3180, 3181. Army ROTC Leadership Laboratory. A practical laboratory of applied leadership and skills. Student-planned, -organized, and -conducted training, oriented toward leadership development. Laboratory topics include marksmanship, unit tactics, and multitiered programs focused on individual skill levels. All uniforms and equipment are provided without cost to the student. Required course for all scholarship and contracted cadets and for any student concurrently enrolled in other Army ROTC courses at the 3000 level or higher.

3241. Army ROTC Intermediate Leadership I. Development of students' ability to evaluate situations; plan and organize training and military tactics; review case studies in leadership management; and develop teaching and briefing skills. Concurrent enrollment in SSR 3180 is mandatory. *Prerequisite:* Permission of instructor.

3342. Army ROTC Intermediate Leadership II. Practical application of squad and platoon leadership in tactical situations – operation of small unit communications systems. Development of the leaders' ability to express themselves, analyze military problems, and prepare and deliver logical solutions. Demanding physical fitness training and performance-oriented instruction in preparation for Summer Field Training. Concurrent enrollment in SSR 3181 is mandatory. *Prerequisite:* Permission of instructor.

3443. Army ROTC Summer Field Training. A six-week off-campus field training course stressing the practical application of leadership management with emphasis on tactical and technical military field skills. *Prerequisites:* Completion of junior-level Military Science and permission of instructor.

4180, 4181. Army ROTC Leadership Laboratory. A practical laboratory of applied leadership and skills. Student-planned, -organized, and -conducted training, oriented toward leadership development. Laboratory topics include marksmanship, small unit tactics, and multitiered programs focused on individual skill levels. All uniforms and equipment is provided without cost to the student. The course must be taken by all scholarship and contracted cadets. Required for any student concurrently enrolled in other Army ROTC courses at the 4000 level or higher.

4341. Army ROTC Advanced Leadership I. Command and Staff functions and operations. Plan and conduct meetings, briefings, and conferences. Introduction to the Army Logistical System and the Personnel Management System. Preparation of after-action reports. Plan and conduct physical training programs. Concurrent enrollment in SSR 4180 is mandatory. *Prerequisite:* Permission of instructor.

4342. Army ROTC Advanced Leadership II. Provides students with a basic working knowledge of the Military Justice System with emphasis on company-level actions and requirements including Law of Land Warfare. Exposes students to standards of ethics for the U.S. Army officer. Provides an understanding of professional roles, responsibilities, and uniqueness of military service. Concurrent enrollment in SSR 4281 is mandatory. *Prerequisite:* Permission