The remaining three 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.

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:

Requirements

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

Elective Courses

Six 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:

		TCH
College Requirements:	ENGL 1301, 1302, Perspectives including ECON 1311, Cultural Formations, and Wellness	29
Mathematics:	MATH 1309 or 1337, and MATH 1310 or 1338*	6
Probability and Statistics:	STAT 2301, 2331 or STAT 4340/CSE 4340	3
Introductory Physics:	PHYS 1313 or 1407, or both 1303 and 1105	3
Computer Science:	CSE 1341 and 2341	6
Electrical Engineering:	EE 1382, 2181, 2355, 2356, 2381, 3181, .3381†	17
Telecommunications:	EE 1305, 3301, 3302, 5301, 5302, 5305	18
Telecommunications Senior Design Sequence:	EE 4301 and 4302	6
Engineering Economy:	EMIS 2360	3
Business Administration:	ACCT 2311, MKTG 3340, OBBP 3370	9
Technical Writing:	ENGL 2301	3
Free Electives:	With adviser approval	20
Minimum total hours required		123

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

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 nontechnical students who want to be more knowledgeable. (Not open to EE majors.)

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

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

2170. EE Laboratory: Design and Analysis of Signals and Systems Using MATLAB. 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, concurrent registration in EE 2370.

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

2305. Creating Interactive Internet Web Sites. Covers programming languages and techniques for two-way communications via the World Wide Web. Goes beyond HTML (Hypertext Markup Language), which is one-way distribution of information for the Web. The techniques covered in this course allow information gathering, such as responses to surveys and conference or seminar registration data, and credit card information needed to create Web sites for electronic commerce. Students are required to attend lectures and labs and will create an e-commerce Web site for a term project. Topics include architecture of the Internet, database software, intermediate and advanced HTML programming techniques, style sheets, frames, pixel mapping, Java Script and Java applets, and other topics as appropriate for the Internet generation. *Prerequisite:* Any approved SMU Information Technology course.

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. *Prerequisite:* EE 2350 (Grade of C- or better), concurrent registration in EE 2122.

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. *Prerequisite:* PHYS 1304. *Corequisite:* MATH 2343.

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. 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:* EE 1382 (Grade of C- or better), MATH 1337, 1338. Concurrent registration in EE 2170.

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

3(1-3)90. Junior Project.

3122. EE Laboratory: Electronic Circuits II. Experiments in analog electronic circuit design. *Prerequisite:* EE 2122 (Grade of C- or better), EE 2322 (Grade of C- or better) and concurrent registration in 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. *Prerequisite:* EE 2181 (Grade of C- or better), EE 2381 (Grade of C- or better) and concurrent registration in 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. *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, 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. *Prerequisite:* EE 3301.

3304. History and Future of Documents in the Digital Era. A looks at the omnipresent and diverse documents that fill our lives from sticky notes to email, contracts to digital signatures, encyclopedias to the World Wide Web. Explores the failure of the paperless society and the future of the document. In this period of digital transition from sedentary text to hypertext, what is the future of the book, the library, the copyright, education? *Prerequisite:* Junior standing.

3311. Solid-State Devices. 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. *Prerequisites:* CHEM 1303 and EE 2350 (Grade of C- or better).

3315. Optoelectronics. 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. *Prerequisite:* EE 2350 (Grade of C- or better).

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

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

3360. Statistical Methods in Electrical Engineering. Introduction to probability, elementary statistics, and random processes. Topics include fundamental concepts of probability, random variables, probability distributions, sampling, estimation, elementary hypothesis testing, basic random processes, stationarity, correlation functions, power-spectral-density functions, and the effect of linear systems on such processes. *Prerequisite:* EE 2370 (Grade of C- or better), 2170 (Grade of C- or better), MATH 2339.

3372. Introduction to Signal Processing. 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 experimentation with real-world signals. *Prerequisite:* EE 2350 (Grade of C- or better), 2370 (Grade of C- or better), 2170 (Grade of C- or better), and MATH 2339.

3373. Communication Systems. 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 modulation schemes, source coding, and channel capacity. *Prerequisite:* EE 3360, and 3372.

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. *Prerequisite:* EE 2381 (Grade of C- or better), and concurrent registration in EE 3181.

4(1-3)90. Senior Project.

4173. EE Laboratory: Wireless Modem Laboratory. 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. Concurrent registration in 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 telecommunications. Depending on the specifics of the project, each student will design, construct, and test a solution and submit a formal report. *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. *Prerequisite:* EE 4301.

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

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

4372. Advanced Topics in Signal Processing. 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. Covers topics in wireless, cellular, and personal communications. Starting with a coverage of topics in digital communication systems such as source and channel encoding, baseband digital communication, digital modulation, and optimum digital receivers, the course will cover basic cellular/mobile and personal communications, frequency allocations, wireless channel models, modulation techniques, handover, digital cellular systems such as TDMA, CDMA, and OFDM, equalization, and diversity reception. *Prerequisite:* EE 3373 and concurrent registration in EE 4173.

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. 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. Concurrent registration in EE 5376 and senior standing.

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. *Restriction*: Junior standing.

5302. Telecommunications Management and Regulation. The managerial sequel to EE 5301, Introduction to Telecommunications. 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.

5303. Fiber Optic Telecommunications. Introductory course designed to familiarize students with practical concepts involved in optical fiber communications systems. Basic optical principles are reviewed. Dielectric slab-waveguides, fiber waveguides, and integrated optics devices are discussed. The major components of a fiber communications link, including optical sources, detectors, and fibers, are covered. *Restriction*: Junior Standing.

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. *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. *Prerequisite:* EE 3311.

5312. Semiconductor Processing Laboratory. A laboratory-oriented elective course for senior and first-year graduate students. Provides 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. *Prerequisite:* EE 3311 .

5314 (ME 5314). Introduction to Micromechanical Systems (MEMS) and Devices. Develops the basics for microelectromechanical devices and systems, including microactuators, microsensors, and micromotors; principles of operation; micromachining techniques (surface and bulk micromachining); IC-derived microfabrication techniques; and thin film technologies as they apply to MEMS. *Prerequisite:* EE 3311.

5321. Semiconductor Devices and Circuits. A study of the basics of 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. *Prerequisites:* EE 3122 and 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. *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. *Prerequisite:* EE 3330.

5333. Antennas and Radiowave Propagation for Personal Communications. Concerned with three important aspects of telecommunications: fixed site antennas, radiowave propagation, and small antennas proximate to the body. The topics include electromagnetics fundamentals; general definitions of antenna characteristics; electromagnetic theorems for antenna applications; various antennas for cellular communications including loop, dipole, and patch antennas; wave propagation characteristics as in earth-satellite communications, radio test sites, urban and suburban paths, and multipath propagation; and radio communication systems. *Prerequisite:* EE 3330.

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

5345. Medical Signal Analysis. A look at the analysis of discrete-time medical signals and images. Topics include the design of discrete-time filters, medical imaging and tomography, signal and image compression, and spectrum estimation. The course project explores the application of these techniques to actual medical data. *Prerequisite:* EE 3372.

5356. 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. *Prerequisites:* EE 2181 (Grade of C- or better), 2381 (Grade of C- or better) and 3311.

5357. CAE Tools for Structured Digital Design. Concentrates on the use of CAE tools for the design and simulation of complex digital systems. Verilog, a registered trademark of Cadence Design Systems Inc., hardware description language will be discussed and used for behavioral and structural hardware modeling. Structured modeling and design will be emphasized. Design case studies include a pipelined processor, cache memory, UART, and a floppy disk controller. *Prerequisites:* EE 2181 (Grade of C- or better) and 2181 (Grade of C- or better).

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

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

5370. Communication and Information Systems. An introduction to communication in modulation systems in discrete and continuous time, information content of signals, and the transition of signals in the presence of noise. Amplitude, frequency, phase and pulse modulation. Time and frequency division multiplexing. *Prerequisite:* EE 3372.

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. *Prerequisite:* EE 3372.

5373. DSP Programming Laboratory. Digital signal processors (DSPs) are programmable semiconductor devices used extensively in digital cellular phones, high-density disk drives, and high-speed modems. This laboratory course focuses on programming the Texas Instruments TMS320C54, a fixed-point processor. The emphasis is on assembly language programming, and the laboratories utilize a hands-on approach that will focus on the essentials of DSP programming while minimizing signal processing theory. Laboratory topics include implementation of FIR and IIR filters, the FFT, and a real-time spectrum analyzer. *Suggested:* Some basic knowledge of discrete-time signals and digital logic systems. *Prerequisite:* EE 3372.

5374. Digital Image Processing. Provides an introduction to the basic concepts and techniques of digital image processing. Topics covered will include characterization and representation of images, image enhancement, image restoration, image analysis, image coding, and reconstruction. *Prerequisite:* EE 5372.

5375. Random Processes in Engineering. An introduction to probability and stochastic processes as used in communication and control. Topics include probability theory, random variables, expected values and moments, multivariate Gaussian distributions, stochastic processes, autocorrelation and power spectral densities, and an introduction to estimation and queuing theory. *Prerequisite:* EE 3360.

5376. Introduction to Communication Networks. An introductory course that surveys basic topics in communication networks with an emphasis on layered protocols and their design. Topics include OSI protocol reference model, data link protocols, local area networks, routing, congestion control, network management, security, and transport layer protocols. Network technologies include telephony, cellular, Ethernet, Internet protocol (IP), TCP, and ATM. Assignments may include lab exercises involving computer simulations. Senior standing and concurrent registration in EE 5176.

5380. Logic Design and Implementation. 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. *Prerequisites:* EE 2181 (Grade of C- or better), 2381 (Grade of C- or better), and either CSE 2340, or EE 3381 and EE 3181.

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. *Prerequisite:* EE 2181 (Grade of C- or better) and EE 2381 (Grade of C- or better). Junior standing.

5385. Microprocessors in Digital Design. Intended to help prepare the digital design engineer for utilization of microprocessors as programmable logic components in digital systems design. Topics include: fundamentals of 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 68332 will be covered. *Prerequisites:* EE 3181 and EE 3381.

ENGINEERING MANAGEMENT, INFORMATION, AND SYSTEMS

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

Professor: Jeffrey L. Kennington, Stephen Szygenda, Margaret H. Duhnam **(Computer Science);** U. Narayan Bhat **(Statistics),** Marion Sobol **(Business)**; **Associate Professors:** Richard V. Helgason, Jeff Tian **(Computer Science); Assistant Professors:** Eli V. Olinick; **Scholar in Residence in EMIS:** Jerrell R. Stracener; **Senior Lecturer:** Thomas Siems; **Lecturer:** Mary Alys Lillard; **Adjunct Faculty:** Karl Arunski, Leslie-Ann Asmus, William David Bell, Joseph H. Dean, Dennis Frailey, Ryan M. Garlick, Ganesh L. Harpavat, James Hinderer, Gerard Ibarra, Eric O. Lentz, Gretchen Miller, Riad A. K. Mohammad, Augustyn Ortynski, David Peters, Oscar K. Pickels, Steven P. Sanazaro, Gheorghe Spiride, Wendy Spring, William Swanson, John Yarrow, Hossam Zaki.

The Department of Engineering Management, Information and Systems (EMIS) brings together the school's technical management and operations areas to offer a Bachelor of Science with a Major in Management Science. This academic program in *management science* focuses on computer models for decision-making and the application of engineering principles and techniques to enhance organizational performance.

The same systems-oriented, mathematical-model-based approach—that has been the cornerstone of engineering for decades—has powerful applications within organizations and their operations. Faculty specializations include optimization, telecommunications network design and management, supply-chain systems, systems engineering, logistics, quality control, reliability engineering, information engineering, benchmarking, operations planning and management, network optimization, and mathematical programming. In other words, management science is where engineering meets business.

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 related issues. Usable or 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, logistics, production, information engineering, and statistics, for example. The methods are used extensively in both the public sector and industry. Hence the Management Science program prepares the technically oriented student to excel in today's competitive business environments.

Bachelor of Science with a Major in Management Science
(122 Term Credit Hours)

Curriculum Requirements

		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, and 3353	9
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:	EMIS 1360, 2360, 3308, 3309, 3360, 4340, 4395, 5362; CSE 1341, 2341, 3365, 4360; ENCE 3302	39
3 TCH from EMIS courses at the 3000 level or above		3
Business:	ACCT 2311, MKTG 3340, OBBP 3370	9
Electives:	Adviser must approve electives	18
Wellness:		2
		122

Note: All Management Science majors must receive a grade of at least C- in all EMIS courses taken in fulfillment of the requirements for the major.

Minor in Management Science

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

EMIS 1360 Introduction to Management Science
EMIS 2360 Engineering Economy
EMIS 3360 Operations Research Models
EMIS 5362 Production and Operations Management
CSE 1341 Principles of Computer Science I
Plus one (1) of the following:
EMIS 4340 Statistics for Engineers and Applied Scientists
EMIS 4395 Senior Design

Multiple Degrees

Because of the flexibility of the curriculum, a majority of Management Science majors receive a second major or one or more minors from a wide range of other disciplines. Examples include a Bachelor of Science, Major in Management Science, plus a second Bachelor's degree in: Economics, Mathematics, Business, Computer Science, History, Psychology, Spanish, and French.

Other Management Science majors continue their studies to obtain a Masters of Science in Engineering Management, Systems Engineering, Information Engineering, or Operations Research. The 4+1 Program permits students to obtain both undergraduate and graduate degrees in a shorter time and with fewer courses than if taken separately or from different universities.

More information on these and other options available to Management Science majors can be found on the EMIS Department web site. This is located at engr.smu.edu/emis.

The Courses (EMIS)

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

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

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

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:* C- or better in MATH 1338. (Must enroll in lab.)

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

3308. Engineering Management. Examines planning, financial analysis, organizational structures, management of the corporation (including its products, services, and people), transfer of ideas to the marketplace, ethics, and leadership skills. *Prerequisite:* Junior standing.

3309. Information Engineering and Global Perspectives. Examines global and information aspects of technology-and information-based companies. *Prerequisite:* Junior standing.

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 EMIS 3360 and EMIS 8360. *Prerequisites:* A knowledge of matrices and an introduction to probability and statistics. (Must enroll in lab.)

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

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

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

5050. Undergraduate Internship Program.

5300. Systems Analysis Methods. Introduction to modeling and analysis concepts, methods and techniques used in systems engineering, design of products and associated production and logistics systems and analysis of operational system performance. Specific topics include: probabilistic and statistical methods, Monte Carlo Simulation, optimization techniques, applications of utility and game theory, and decision analysis.

5301. Systems Engineering Process. The discipline, theory, economics, and methodology of systems engineering is examined. The historical evolution of the practice of systems engineering is reviewed, as are the principles that underpin modern systems methods. The economic benefits of investment in systems engineering and the risks of failure to adhere to sound principles are emphasized. An overview perspective distinct from the traditional design- and analytical-specific disciplines is developed.

5303. Integrated Risk Management. An introduction to risk management based upon integrated trade studies of program performance, cost, and schedule requirements. Topics include risk planning, risk identification and assessment, risk handling and abatement techniques, risk impact analysis, management of risk handling and abatement, and subcontractor risk management. Integrated risk management methods, procedures, and tools will be examined.

5305. Systems Optimization and Analysis. Emphasis is placed on the systems analysis process as the rational basis for developing optimum products consistent with customer requirements. Specific topics include requirements analysis, effectiveness analysis, operational analysis, environmental analysis, and life cycle analysis. Modeling and optimization techniques are introduced as necessary.

5307. Systems Integration and Test. The process of successively synthesizing and validating larger and larger segments of a partitioned system within a controlled and instrumented framework is examined. System integration and test is the structured process of building a complete system from its individual elements and is the final step in the development of a fully functional system. The significance of structuring and controlling integration and test activities is stressed. Formal methodologies for describing and measuring test coverage, as well as sufficiency and logical closure for test completeness, are presented. Interactions with system modeling techniques and risk management techniques are discussed. The subject material is based upon principles of specific engineering disciplines and best practices, which form a comprehensive basis for organizing, analyzing, and conducting integration and test activities.

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

5320. Systems Engineering Management. Concepts, processes, best practices, methods and techniques for management of the systems engineering process from need, through concepts exploration, demonstration and validation, engineering and design and test and evaluation to ensure cost, schedule and technical performance. Specific topics include Systems Engineering Management Plan (SEMP) and Integrated Master Program Schedule (IMPS), technical performance measures, organizing for systems engineering, integrated product and process development (IPPD) and supplier evaluation, selection and control.

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

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

5351. Enterprise Fundamentals. An overview of business fundamentals, spanning the range of all functional areas: management, marketing, operations, accounting, information systems, finance, and legal studies.

5352. Information System Architecture. The architecture of an information system (IS) defines that system in terms of components and interactions among those components. This course addresses IS hardware and communications elements for information engineers, including computer networking and distributed computing. It addresses the principles, foundation technologies, standards, trends, and current practices in developing an appropriate architecture for Web-based and non-Internet information systems.

5353. Information System Design Strategies. Surveys the fundamentals of software engineering and database management systems (DBMS) for information engineers. Covers the principles, foundation technologies, standards, trends, and current practices in data-centric software engineering and systems design, including object-oriented approaches and relational DBMS. The focus is on system design, development, and implementation aspects, and not the implementation in code.

5355. Engineering Operations. The management of a technical organization's operations can contribute to the strategic goals and objectives of the enterprise. By analyzing and managing operations as systems, strategic choices are shown to drive design and operating decisions. The course covers the tools and techniques for solving problems to achieve the overall goals and strategies of manufacturing and services organizations.

5357. Decision-Support Systems. Covers the development and implementation of a data-centric, decision-support system (DSS), the underlying technologies, and current applications and trends. Topics include: decision-making, DSS components, optimization models, expert systems, data mining and visualization, knowledge discovery and management, and executive information systems.

5359. Information Engineering Seminar. Topics in management of information in specific industries or application areas. May be repeated for credit when the topics vary. *Prerequisite:* EMIS 5360.

5360. Management of Information Technologies. Defines the management activities of the overall computer resources within an organization or government entity. Consists of current topics in strategic planning of computer resources, budgeting and fiscal controls, design and development of information systems, personnel management, project management, rapid prototyping, and system life cycles.

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

5362. Production and Operations 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:* C- or better in EMIS 3360.

5364 (STAT 5344). Statistical Quality Control. An introduction to statistical quality-control methods that can be applied to meet the demand for ever-increasing levels of product and service quality. Basic methods and tools for analyzing, controlling, and improving product and service quality are covered. Probabilistic and statistical techniques are applied to modeling and analysis of variability associated with product production and service processes. Topics include analysis of product design tolerances, six-sigma techniques, statistical analysis of process capability, statistical process control using control charts, quality improvement, and acceptance sampling. *Prerequisite:* EMIS 4340 or 5370.

5369. Reliability Engineering. An introduction to reliability engineering concepts, principles, techniques, and methods required for design and development of affordable products and services that meet customer expectations. Topics include reliability concepts and definitions, figures-of-merit, mathematical models, design analysis and trade studies, reliability testing including types of tests, test planning and analysis of test results, and statistical analysis of reliability data. 1 TCH Design. *Prerequisite:* C- or better in EMIS 4340 or 5370.

5370 (STAT 5340). Statistical Probability and Statistics for Scientists and Engineers. An introduction to fundamentals of probability and distribution theory, statistical techniques used by engineers and physical scientists. Examples of tests of significance, operating characteristic curves, tests of hypothesis for one or two parameters, estimation, analysis of variance, and the choice of a particular experimental procedure and sample size. *Prerequisite:* C- or better in MATH 2339 or equivalent.

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

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

ENVIRONMENTAL AND CIVIL ENGINEERING

Professor Bijan Mohraz, **Chair**

Professor: Bijan Mohraz; **Assistant Professors:** Alfredo Armendariz, John H. Easton, Paul Krueger, David Willis; **Senior Lecturer:** Roger O. Dickey; **Adjunct Faculty:** John Barber, Arthur Beck, Mark K. Boyd, Gerald R. Carney, James Duke, Ted Dumas, Carl Edlund, Fawsi Elghadamsi, Edward Forest (Retired Chair), Regina Gaiotti, Bill Gunnin, Anwar Hirany, Louis

Hosek, Raji Josiam, Jim Langford, Donald L. Legg, Paul Martin, K.S. (Raj) Rajagopalan, Jon D. Rauscher, Cecil Smith (Professor Emeritus), D. Blair Spitzberg, John Stanley, Bennett Stokes, Ken Thomas, Jim Veach, Gregory Wilson, Scott Woodrow.

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

Environmental and civil engineering are inextricably linked. While civil engineering focuses on the infrastructure of modern society, environmental engineering is concerned with the well-being and health of the population and the environment. Environmental and civil engineering entered the early 1900s as a single integrated discipline, when it was critical to address sanitary problems to protect public health, and to develop regional water supplies and the civil infrastructure to support rapid urbanization and early industrialization. Separate disciplines gradually emerged, evolving and broadening to address the overall quality and function of modern society — preserving the environment while enabling the realization of an enriched life through technology.

Environmental Engineering and Environmental Science Programs. Today, the environmental field is dynamic and wide-ranging, comprising many different disciplines and professional roles. Environmental engineering and science involve not only traditional water and wastewater management, but also the management of hazardous and radioactive materials, pollution prevention and waste minimization, innovative hazardous waste treatment and site remediation processes, environmental and occupational health, resource conservation and recovery, sustainable development of natural resources, and air quality management and pollution control. In addition, modern manufacturing, both domestic and worldwide, is focusing on products fabricated from recycled and natural materials that are both competitive and harmlessly degraded in the environment. The trend toward global manufacturing will grow stronger in the years ahead. Environmental challenges presented by this movement must be overcome if the economic and life-style benefits of globalization are to be extended to all peoples of the world.

The educational objectives of the environmental engineering program are consistent with the missions of the Environmental and Civil Engineering Department, the School of Engineering, and the overall institutional mission of SMU. These educational objectives, determined based on the needs of the program's various constituencies, are:

1. Graduate highly educated engineers with the appropriate interdisciplinary knowledge to assume important management and leadership positions in a globally competitive world.
2. Ensure that graduates have a deep understanding of the scientific principles and the analytical and problem-solving skills to fully participate either as environmental managers or as process/design engineers in this increasingly essential field.

3. Prepare graduates with sufficiently broad knowledge to pursue advanced academic or professional degrees in engineering, medicine, law, business, or public policy.
4. Prepare graduates for licensing as professional engineers.
5. Instill in graduates the personal qualities of leadership, the facility for effective written and verbal communication, and an abiding commitment to lifelong learning.

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

Civil Engineering Program. Civil engineers are engaged in planning, design, construction, maintenance, and management of the infrastructure of modern society. They are responsible for the design of water supply and wastewater treatment systems; transportation systems such as highways, railways, waterways, mass transit, airports, ports, and harbors; dams, reservoirs, and hydroelectric power plants; thermoelectric power plants; transmission and communication towers; high-rise buildings; and even aircraft and aerospace structures, shuttles, and space stations. Every major structure critical to this country, and global society, depends on the work of civil engineers.

The educational objectives of the civil engineering program are consistent with the missions of the Environmental and Civil Engineering Department, the School of Engineering, and the overall institutional mission of SMU. These educational objectives, determined based on the needs of the program's various constituencies, are:

1. Graduate highly educated engineers with the appropriate interdisciplinary knowledge to assume important management and leadership positions in a globally competitive world.
2. Ensure that graduates have a deep understanding of the scientific principles and the analytical and problem solving skills to fully participate either as civil engineering managers or design engineers in this increasingly essential field.
3. Prepare graduates with sufficiently broad knowledge to pursue advanced academic or professional degrees in engineering, law, business, or public policy.
4. Prepare graduates for licensing as professional engineers.
5. Instill in graduates the personal qualities of leadership, the facility for effective written and verbal communication, and an abiding commitment to lifelong learning.

The civil engineering program prepares graduates for professional practice and advanced study through a focus in the following areas: (1) structural analysis and design, (2) soil mechanics and foundations, (3) transportation systems, (4) water supply and wastewater utilities, and (5) water resource systems.

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

Bachelor of Science in Environmental Engineering
Bachelor of Science in Environmental Engineering with a Premedical Specialization
Bachelor of Science in Environmental Science
Bachelor of Science in Environmental Science with a Premedical Specialization
Bachelor of Science in Civil Engineering

The B.S. degree in Environmental Engineering, B.S. degree in Environmental Engineering with a Premedical Specialization, and B.S. degree in Civil Engineering are consistent with Accreditation Board of Engineering and Technology (ABET) accreditation guidelines, and with preparation for the Fundamentals of Engineering (FE) examination, the first step toward licensure as a Professional Engineer (P.E.). Indeed, SMU has the only ABET accredited, undergraduate Environmental Engineering Program in the state of Texas. Engineering design is integrated throughout the environmental and civil engineering curricula, each culminating in a major design experience based on the knowledge and skills acquired in earlier course work. In their senior year, the department's engineering students are required to take two terms of design where teams of two to four students work closely on practical projects sponsored by industry and government. Senior design projects incorporate engineering standards and realistic constraints including most of the following considerations: economic, environmental, sustainability, manufacturability, ethical, health and safety, social, and political. The department's engineering curricula ensure that students develop an understanding of the concepts of professional engineering practice including ethical responsibilities, effective oral and written communication, engineering management and entrepreneurship, functioning on multidisciplinary teams, procurement, bidding, interaction of design and construction professionals, professional licensing, and the need for lifelong learning.

The B.S. degree in Environmental Science and the B.S. degree in Environmental Science with a Premedical Specialization are designed to meet the professional goals of students whose environmental interests are broader. These programs offer the student greater depth with respect to the sciences, and greater course flexibility with respect to electives.

Departmental Facilities

The undergraduate and research laboratories of the department include dedicated space for air quality and meteorology, industrial hygiene, and water quality. The air quality and meteorology and water quality laboratories are capable of conducting sophisticated chemical analyses of air samples, and assessing the quality of water supplies and wastes and the effectiveness of water and waste treatment procedures. Major equipment includes several spectrophotometers including atomic absorption (AA), inductively coupled plasma (ICP) emission for low-level heavy metals analysis, and two Hewlett-Packard gas chromatographs (GC). Other equipment includes continuous ambient air monitoring equipment, a UV/visible spectrophotometer, pH and other specific ion meters, incubating ovens, microscopes, furnaces, centrifuges, dissolved oxygen meters, a Mettler titrator for chemical and acid/base surface experiments, several temperature control baths, and a tumbler for constant temperature studies. The air quality and meteorology laboratory includes state-of-the-art airflow, pressure, and volume measurement instrumentation. The industrial hygiene laboratory includes an inventory of the latest state-of-the-art personal monitoring equipment for assessing occupational exposure to a variety of industrial process stressors including: asbestos, noise, total and respirable dust, metals, radiation, and heat stress.

A dedicated computer laboratory is maintained for the department's students including personal computers, high-resolution color monitors, and laser printers. The computers are connected, through a high-speed network, to the computer systems of the School of Engineering and SMU, as well as off-campus systems via the Internet. The computer network provides access to general applications software and specialized software for engineering problems including air dispersion modeling, computer aided design (CAD), hydrologic and hydraulic modeling for water resource systems, structural analysis and design, and water quality modeling.

New civil engineering laboratories are under development in the disciplines of soil mechanics, hydraulics and hydrology, and structural engineering. In the near term, civil engineering laboratory courses will utilize existing laboratory facilities, including the Mechanical Engineering Department's Mechanics of Materials Laboratory, and Thermal and Fluids Laboratory.

Bachelor of Science in Environmental Engineering

Curriculum Requirements		***TCH***
College Requirements:	Humanities, Social Sciences, and SMU required courses	23
Mathematics and Statistics:	MATH 1337, 1338, 2339, 2343; STAT 4340	15
Sciences:	Biology: BIOL 1401 Chemistry: CHEM 1113, 1114, 1303, 1304, 3117, 3371 Earth Science: ENCE 1331 Meteorology Physics: PHYS 1105, 1303	23
Engineering Science and Design	Computer Science and Engineering: CSE 1341 Civil/Mechanical Engineering: ENCE 2310, 2331, 2342	12
Environmental Engineering and Design:	Environmental: ENCE 1301 or 1302, 2304, 2421, 3323, 3341, 3431, 3451, 4354, 4380, 4381	33
Environmental Technical Electives:	Selected with adviser approval	9
Engineering Leadership:	Computer Science and Engineering: CSE 4360 Engineering Management, Information and Systems: EMIS 3308, 3309 Environmental and Civil Engineering: ENCE 3302	12
Minimum total hours required		127

Bachelor of Science in Environmental Engineering
(Premedical Specialization)

Curriculum Requirements		***TCH***
College Requirements:	Humanities, Social Sciences, and SMU required courses	23
Mathematics and Statistics:	MATH 1337, 1338, 2339, 2343; STAT 4340	15
Sciences:	Biology: BIOL 1401, 1402, 3304, 3306 Chemistry: CHEM 1113, 1114, 1303, 1304, 3117, 3118, 3371, 3372 Earth Science: ENCE 1331 Meteorology Physics: PHYS 1105, 1106, 1303, 1304	41
Engineering Science and Design:	Computer Science and Engineering: CSE 1341 Civil/Mechanical Engineering: ENCE 2310, 2331, 2342	12
Environmental Engineering and Design:	Environmental: ENCE 1301 or 1302, 2304, 2421, 3323 3341, 3431, 3451, 4354, 4380, 4381	33
Environmental Technical Electives:	Selected with adviser approval	9
Minimum total hours required		133

Bachelor of Science in Environmental Science

Curriculum Requirements		*TCH*
College Requirements:	Humanities, Social Sciences, and SMU required courses	29
Mathematics and Statistics:	MATH 1337, 1338, 2339, 2343; STAT 4340	15
Sciences:	Biology: BIOL 1401 Chemistry: CHEM 1113, 1114, 1303, 1304, 3117, 3371 Earth Science: ENCE 1331 Meteorology Physics: PHYS 1105, 1303	23
Engineering Science:	Computer Science and Engineering: CSE 1341 Civil/Mechanical Engineering: ENCE 2331, 2342	9
Environmental Engineering:	Environmental: ENCE 1301 or 1302, 2304, 2421, 3323, 3341, 3431, 3451, 4354	27
Environmental Technical Electives:	Selected with adviser approval	9
Technical and Engineering Leadership Electives:	Free electives	12
Minimum total hours required		124

Bachelor of Science in Environmental Science *(Premedical Specialization)*

Curriculum Requirements		*TCH*
College Requirements:	Humanities, Social Sciences, and SMU required courses	29
Mathematics and Statistics:	MATH 1337, 1338, 2339, 2343; STAT 4340	15
Sciences:	Biology: BIOL 1401, 1402, 3304, 3306 Chemistry: CHEM 1113, 1114, 1303, 1304, 3117, 3118, 3371, 3372 Physics: PHYS 1105, 1106, 1303, 1304	38
Engineering Science:	Computer Science and Engineering: CSE 1341 Civil/Mechanical Engineering: ENCE 2331, 2342	9
Environmental Engineering:	Environmental: ENCE 1301 or 1302, 2304, 2421, 3323, 3341, 3431, 3451, 4354	27
Environmental Technical Electives:	Selected with adviser approval	3
Technical or Engineering Leadership Elective:	Free elective	3
Minimum total hours required		124

Bachelor of Science in Civil Engineering

Curriculum Requirements		*TCH*
College Requirements:	Humanities, Social Sciences, and SMU required courses	23
Mathematics and Statistics:	MATH 1337, 1338, 2339, 2343; STAT 4340	15
Sciences:	Chemistry: CHEM 1113, 1114, 1303, 1304 Earth Science: GEOL 1301 or 1315 Physics: PHYS 1105, 1106, 1303, 1304	19
Engineering Science and Design:	Computer Science and Engineering: CSE 1341 Civil/Mechanical Engineering: ENCE 2320, 2331, 2342/2142	13
Civil Engineering and Design:	Civil: ENCE 1301 or 1302, 2304, 2310, 2340/2140, 3323, 3350, 4350, 4354, 4380, 4381, 4385, 5372	37

Curriculum Requirements		*TCH*
Civil Engineering Technical Electives:	Selected with adviser approval	6
Engineering Leadership:	Computer Science and Engineering: CSE 4360 Engineering Management, Information and Systems: EMIS 3308, 3309 Environmental and Civil Engineering: ENCE 3302	12
Minimum total hours required		125

Minor in Environmental Engineering

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

ENCE 2304 Introduction to Environmental Engineering and Science
ENCE 2421 Aquatic Chemistry
ENCE 3431 Fundamentals of Air Quality I
ENCE 4329 Design of Water and Wastewater Systems
ENCE 4354 Environmental Engineering Principles and Processes

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

Minor in Civil Engineering

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

ENCE 2310 Statics
ENCE 2340/2140 Mechanics of Deformable Bodies
ENCE 3350 Structural Engineering I: Analysis and Design in Steel
ENCE 4350 Structural Engineering II: Analysis and Design in Concrete
ENCE 4385 Soil Mechanics and Foundations

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

The Courses (ENCE)

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

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

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

2140. Mechanics of Materials Laboratory. Experiments in mechanics of deformable bodies, to complement ENCE 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. *Corequisite or Prerequisite:* ENCE 2340.

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 ENCE 2342. *Corequisite or Prerequisite:* ENCE 2342.

2304. Introduction to Environmental Engineering and Science. Introduction to a scientific and engineering basis for identifying, formulating, analyzing, and understanding various environmental problems. Material and energy balances are emphasized for modeling environmental systems and processes. Although traditional materials in air and water pollution are examined, emphasis is 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 are derived and applied, and treatment technologies introduced. *Prerequisites:* CHEM 1303 and MATH 1338.

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:* ENCE 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. *Prerequisite:* ENCE 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. *Prerequisite:* MATH 1338.

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

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

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

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:* ENCE 2342 and MATH 2343.

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

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

3350. Structural Engineering I: Analysis and Design in Steel. Analysis of statically determinate structural systems; computation of reactions, shears, moments, and deflections of beams, trusses, and frames. Study of behavior and design of metal structures; flexural and axial members; basis for proportioning of members and connections. Use of computers in analysis and design. *Prerequisites:* ENCE 2340/2140.

3353. Introduction to Environmental Toxicology. The physiological and biochemical effects of physical, chemical, and biological processes are linked to factors present in the environment. Natural phenomena are described in terms of the carbon, oxygen, sulfur, phosphorus, and heavy metal cycles. The processes by which anthropogenic chemicals enter the environment and their complex effects on living organisms are examined in detail. *Prerequisite:* BIOL 1401. *Corequisite or Prerequisite:* CHEM 3371.

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:* ENCE 2304.

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

3451. Principles of Industrial Hygiene, Occupational Health, 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.

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

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

4350. Structural Engineering II: Analysis and Design in Concrete. Analysis of statically indeterminate structures. Study of strength, behavior, and design of reinforced concrete members and structures; members subjected to flexure, shear, and axial loads. *Prerequisite:* ENCE 3350.

4354. Environmental Engineering Principles and Processes. Waste minimization and pollution prevention techniques and objectives are introduced. A comprehensive study is made of biological, chemical, and physical principles and treatment strategies for controlling pollutant emissions. Equal emphasis is placed on underlying theory and practical engineering application of both common and innovative water and wastewater treatment processes. Design equations, procedures, and process models are rigorously derived for chemical/biological reactors and physical unit operations. Emphasis is placed on engineering analysis and application of process modeling techniques for design of unit processes to achieve specific treatment objectives. *Prerequisites:* CHEM 1303, ENCE 2304 and 2342, and MATH 2343.

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

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

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

5311. Environmental and Hazardous Waste Law. Federal environmental laws, with emphasis on laws dealing with hazardous substances, such as CERCLA and RCRA; regulations and the regulatory framework; definitions and substantive requirements; roles of the States and the Federal EPA; compliance and enforcement; case studies.

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

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

5314. Environmental Regulations and Compliance. Practical knowledge of federal and state environmental permitting processes and procedures is provided. Regulatory requirements are reviewed with emphasis on the 40 CFR regulations for water, air, and solid and hazardous waste. Air, water, storm water, and waste permits are reviewed, as well as permits-by-rule. Also explored are the consequences of non-compliance with regulations by presenting enforcement options available to government agencies.

5315. Integrated Waste Management. Comprehensive introduction to the fundamentals of the complex interdisciplinary field of hazardous waste management; current management practices; treatment and disposal methods; and site remediation. Topics include detailed case studies and design examples to evaluate the effectiveness of different treatment and containment technologies in addressing today's hazardous waste situations.

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

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

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

5331. Air Pollution Management and Engineering. This course is geared towards graduate students interested in the science, engineering, public health, and economic aspects of air quality. Students will develop deep understanding and broad knowledge of the sources and properties of air pollutants, transport of pollutants in the environment, and government regulation of air quality. In addition, the operation and design of air pollution control systems are reviewed. Also discussed are the science and national and international policies relating to greenhouse gas emissions, global climate change, and stratospheric ozone depletion. A series of design projects reinforce the material presented in lecture. *Prerequisites:* CHEM 1304, MATH 1337 or equivalent, and PHYS 1303 or equivalent.

5332. 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. *Prerequisite:* MATH 2343.

5333. Laboratory Methods in Environmental Engineering. Students are provided 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. Format provides two hours of lecture and three hours of laboratory component. *Prerequisite:* ENCE 5313 or two terms of undergraduate chemistry.

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

5335. Aerosol Science, Engineering, and Control Systems Design. This course is for graduate and upper-level undergraduate engineering students interested in the fundamental and advanced principles of aerosol science and engineering. The properties, behavior, and measurement of airborne particles are specifically reviewed. The origin and properties of atmospheric aerosols and the production of industrial and pharmaceutical aerosols are discussed. Students will study and develop designs for air pollution control equipment for stationary sources like power plants and mobile sources like diesel engines. Advanced filtration techniques for semiconductor clean rooms and other applications are reviewed. *Prerequisites:* CHEM 1304, ENCE 3431 or ENCE 2342 or equivalent.

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:* ENCE 2340 or equivalent.

5350. Introduction to Environmental Management Systems. An in-depth introduction to environmental management systems (EMSs). Includes systems such as EMAS, Responsible Care, OSHAS 18000, ISO 14000, and the Texas EMS program. Takes a step-by-step look at the ISO 14001 standard from the policy statement to the management review, and allows students to fully understand the Plan-Do-Check-Act approach of the system. Also introduces students to management system auditing, the requirements of a system auditor, and the certification process.

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

5352. Management of Radioactive Hazards. Principles of radioactive material production, uses, and hazards are presented with emphasis on their safe control and management. Topics in health physics and radiation protection related to the commercial nuclear industry are examined including uranium fuel production, light water reactor technologies, and industrial and medical uses of radioactive byproduct materials. Risk assessment methods and hazard management connected to the fuel cycles will be developed. The regulation of radioactive materials will be studied with emphasis on licensing of regulated industries, radioactive material transportation, radioactive waste management and disposal, radiological emergency preparedness, and decommissioning. *Prerequisite:* ENCE 5313.

5353. Environmental Epidemiology. Introduction to the science of epidemiology. Design and conduct of studies examining health effects of environmental exposures. Strengths and limitations of research strategies and interpretation of study results. Areas of interest include air and water pollution, lead, and biological marker outcomes.

5361. Matrix Structural Analysis and Introduction to Finite Element Methods. A systematic approach to formulation of force and displacement method of analysis; representation of structures as assemblages of elements; computer solution of structural systems. *Prerequisite:* ENCE 4350 or equivalent.

5362. Engineering Analysis with Numerical Methods. Applications of numerical and approximate methods in solving a variety of engineering problems. Examples include equilibrium, buckling, vibration, fluid mechanics, thermal science, and other engineering applications. *Prerequisite:* Permission of instructor.

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

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

5365. Introduction to Construction Management. Construction practice techniques and current technological tools are examined. Included are cost estimating, bidding, contracts and contract bonds, risk and umbrella excess insurance, labor law and labor relations. Building codes and regulations are examined. Business methods with respect to managing project time and cost, including typical forms used in construction, are addressed.

5366. Introduction to Facilities Engineering Systems. The inter-relationships of fire protection, HVAC, electrical, plumbing, lighting, telecommunications, energy management systems for buildings are examined. A life-cycle approach examines each of these systems with respect to cost, durability, maintainability, operability, and safety. Facility operations, facility maintenance and testing, and assessments are discussed.

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

5369. Electrical, Mechanical and Piping Systems for Buildings. Mechanical and electrical systems for buildings are examined with emphasis on practical aspects of the subjects. Space planning and architectural considerations, including cost and environmental impact of the mechanical and electrical systems are presented. *Prerequisites:* Undergraduate introduction to electrical circuits, classical mechanics, and fluid dynamics or instructor's approval.

5370. Facility Planning. The overall planning process for construction projects is presented. The three divisions of planning: program planning, project planning, and activity planning are presented in an integrated manner. Included are different modeling approaches for the planning process.

5371. Facility Financial and Asset Management. Financial analysis and reporting, concepts and methods of accounting, budgeting, and evaluation of projects are examined. The role of facility managers in affecting corporate earnings and valuations is presented. The management of the facility over its entire life-cycle extending from planning and budgeting to the management of its assets and construction projects is included.

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

5373. Prestressed Concrete. Theory and application of prestressed concrete members, time-dependent deflections, and continuous prestressed beams. *Prerequisites:* ENCE 4350 and 5361.

5377. Advanced Steel Design. Behavior and design of steel structures including general methods of plastic analysis, plastic moment distribution, steel frames, unbraced and braced frames, and composite construction. *Prerequisites:* ENCE 3350, 4350 and 5361.

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

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

5385. Advanced Soil Mechanics. Physicochemical properties of soil and soil stabilization. Advanced theories of soil deformation and failure as applied to slope stability and lateral loads. Soil-water interaction in earthen dams. *Prerequisite:* ENCE 4385.

5386. Foundation Engineering. Application of soil mechanics principles to the design and construction of shallow and deep foundations. Topics include: subsurface investigation procedures to obtain soil parameters for design and construction of structure foundations, bearing capacity and settlement analyses, construction procedures, and soil improvement techniques. *Prerequisite:* ENCE 4385.

5090. ENCE Seminar. Lectures by invited speakers from industry and academia, including SMU faculty and students, dealing with engineering practice and research topics of current interest in environmental and civil engineering. All students, staff, and faculty are invited.

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

MECHANICAL ENGINEERING

Professor Yildirim Hürmüzlü, **Chair**

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

Michael Cassidy, **Director, External Programs**

Professors: Jack Holman, Yildirim Hürmüzlü, David B. Johnson, Radovan Kovacevic, José Lage, Bijan Mohraz, Peter E. Raad; **Associate Professor:** Charles M. Lovas; **Assistant Professors:** Gemunu S. Happawana, Paul Krueger, David Willis; **Lecturer:** Dona T. Mularkey;

Adjunct Faculty: Bogdan Antohe, Terry V. Baughn, Elena Borzova, Michael Cassidy, Regina Gaiotti, Jerry Gannaway, Ramon Goforth, Craig L. Lee, David Nowacki, Albert Petrasek, Rod Pipinich, Donald C. Price, Natarajan Ramanan, Edmund Richer, James Wilson, Chris Witzke; **Emeritus Professors:** Charles E. Balleisen, Paul F. Packman, Cecil H. Smith, Hal Watson Jr., Edmund Weynand.

Mechanical Engineering is a very diverse, dynamic, and exciting field. Because of the wide-ranging technical background attained, mechanical engineers have the highest potential for employment after graduation with exceptional mobility necessary for professional growth even during bear-market conditions. Mechanical engineers apply their creative knowledge to solve critical problems in several different areas, such as bio-engineering (e.g., drug-delivery; artificial organs), construction, design and manufacturing, electronics, energy (e.g., production, distribution and conservation), maintenance (individual machinery and complex installations), materials processing, medicine (diagnosis and therapy), national security and defense, packaging, pollution mitigation and control, robotics and automation, sensors, small scale devices, and all aspects of transportation including space travel and exploration.

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

The program genuinely prepares students to be creative by providing a solid background in fundamentals of science and engineering without compromising the practical aspects of mechanical engineering. Essential entrepreneurial know-how, interpersonal skills, and the importance of lifelong learning complement the educational experience of students. The department stimulates professional and social leadership by providing, among others, opportunities for students to participate in the SMU Student Section of the American Society of Mechanical Engineers and on the SMU Tau-Sigma Chapter of Pi-Tau-Sigma, the National Honorary Mechanical Engineering Fraternity.

The curriculum consists of two major stems, namely, Solid Mechanics and Thermal and Fluids, interlaced via practical mechanical engineering design throughout the curriculum. In the senior year, teams of students are guided through a complete Design Project, all the way from concept to construction to testing, with support from industries, foundations and volunteer professionals. State-of-the-art software, computers, and laboratory equipment support the high-quality education provided to students. Moreover, undergraduate students are encouraged to participate in research projects conducted by faculty and to consider extending their studies toward a graduate degree in Mechanical Engineering at SMU or elsewhere.

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

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

Specific educational objectives of the Mechanical Engineering undergraduate program are to produce graduates who:

1. Can apply the principles of mathematics, science, and engineering;
2. Are knowledgeable in thermal systems and mechanical systems as well as of the relationships among processes, process equipment, integrated design, and performance;
3. Can define problems involving design in both thermal systems and mechanical systems and are capable of developing and evaluating alternate designs as well as implementing design solutions;
4. Communicate effectively and who demonstrate an ability to function on multidisciplinary teams;
5. Can use modern engineering tools for conducting analyses, accomplishing designs, and communicating effectively;
6. Understand their responsibility to their profession and society in a global context and who are prepared for and realize the importance of lifelong learning; and
7. Have the necessary education in the arts, humanities, and ethics.

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

The Mechanical Engineering Department offers the following degrees:

Bachelor of Science in Mechanical Engineering
Bachelor of Science in Mechanical Engineering
with an Engineering Management and Entrepreneurship Specialization
Bachelor of Science in Mechanical Engineering
with a Manufacturing Specialization
Bachelor of Science in Mechanical Engineering
with a Premedical Specialization
Master of Science in Mechanical Engineering
Master of Science in Manufacturing Systems Management
Master of Science in Packaging of Electronic and Optical Devices
Doctor of Philosophy in Mechanical Engineering

In addition, a minor in Mechanical Engineering is available to interested students. Moreover, the department cooperates with the Mathematics Department to offer dual Bachelor of Science degrees in Mechanical Engineering and Mathematics, and with the Physics Department to offer dual Bachelor of Science degrees in Mechanical Engineering and Physics.

Departmental Facilities

In support of the teaching and research endeavors of our department, several instructional and research laboratories are available, including:

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.

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

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

High-Power Laser Processing Laboratory. This laboratory provides first-hand experience in the application of high-energy light (focused laser) to process different types of materials, including forming, cutting, drilling, joining, coating, and material property modification. The laboratory is equipped with a high-power MultiWave Nd:YAG laser with a power of 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.

Laboratory for Porous Materials Applications. This laboratory is devoted to the design, analysis and testing of porous media-based systems and devices, including next generation cooling devices, filters, chemical reactors, and mixers. The laboratory is equipped with instrumentation necessary for measuring effective thermohydraulic properties, including effective conductivity, permeability, and inertia coefficient.

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

MicroMachining Laboratory. This laboratory is equipped with lasers and Photonics equipment specifically for the fabrication of devices at the microscale.

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.

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.

Submicron Electro-Thermal Sciences Laboratory. This laboratory is dedicated to the experimental research and computational modeling of submicron integrated circuits. The laboratory features a laser-based thermo-reflectance measurement system, a microwave integrated circuit scalar performance electrical measurement system, and an adaptive thermal numerical solution package.

Systems Laboratory. Equipped for computational and experimental research in biomechanics, dynamics, and control.

Thermal and Fluids Laboratory. Equipment in this laboratory is used for instruction in experimental heat transfer, thermodynamics, and fluid mechanics. Modern equipment is available for conducting experiments on energy conservation, aerodynamics, internal combustion engine, HVAC systems, convective cooling of electronics, heat exchangers, and interferometric visualization. State-of-the-art systems support automatic control and data acquisition.

Welding Laboratory. The laboratory is equipped with three fully computerized welding cells (for gas tungsten arc welding, gas metal arc welding, and plasma arc welding) to promote high-quality research and technological innovations in arc and plasma welding.

Curriculum in Mechanical Engineering

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

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

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

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

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

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

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

Bachelor of Science in Mechanical Engineering

Curriculum Notes

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

Curriculum Requirements		***TCH***
General Education:	English 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics and Sciences:	Math 1337, 1338, 2339, 2343 and Statistics 4340 or equivalent. Physics 1304, 1403; Chemistry 1303; two additional 3000 level or higher Math or Science courses with the approval of the student's adviser.	31
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381, and 5322.	53
Advanced Major Electives:	Must be selected from 3000 level or higher ME courses with the approval of the student's adviser.	12
Leadership Electives:	Select two from EMIS 3308, EMIS 3309, ENCE 3302, or CSE 4360.	6
Wellness I and II:		2
Minimum total hours required		125

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 Bachelor of Science in Mathematics.

Curriculum Notes

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

Curriculum Requirements		***TCH***
General Education:	English 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics:	Math 1337, 1338, 2339, 2343, 3315, 3337, STAT 4340/CSE 4340 or STAT 5340/CSE 5370, CSE 1340 or 1341 plus two advanced electives as defined in the description of the Mathematics major.	30

Curriculum Requirements		*TCH*
Sciences:	Physics 1304 and 1403; Chemistry 1303.	10
Mechanical Engineering:	ME 1202, 1102, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381, and 5322.	50
Advanced Major Electives:	Must be selected from 3000 level or higher ME courses with the approval of the student's adviser.	9
Leadership Electives:	Select two from EMIS 3308, EMIS 3309, ENCE 3302, or CSE 4360	6
Wellness I and II:		2
Minimum total hours required		128

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

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

Curriculum Notes

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

Curriculum Requirements		*TCH*
General Education:	English 1301, 1302, Perspectives and Cultural Formation courses.	21
Mathematics:	Math 1337, 1338, 2339, 2343, Statistics 4340.	15
Sciences:	Physics 1303, 1304, 3305, 3344, 3345, 3374, 4211, 4392, 5382, 5383 and two advanced physics electives; Chemistry 1303.	38
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381, and 5322.	50
Leadership Elective:	Select one from EMIS 3308, EMIS 3309, ENCE 3302, or CSE 4360.	3
Wellness I and II:		2
Minimum total hours required		129

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, namely Management and Entrepreneurship, Manufacturing, and Premedical. 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 *(Engineering Management and Entrepreneurship Specialization)*

The Mechanical Engineering Department offers a B.S.M.E. degree with an Engineering Management and Entrepreneurship Specialization. This program includes required courses in Engineering Management, Information Engineering and Global Perspectives, Technical Entrepreneurship, and Technical Communications, while at the same time satisfying the requirements for an accredited degree in mechanical engineering.

Curriculum Notes

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

Curriculum Requirements		***TCH***
General Education:	English 1301, 1302, Perspectives and Cultural Formations Courses.	21
Mathematics and Sciences:	Math 1337, 1338, 2339, 2343 and Statistics 4340 or equivalent. Physics 1304, 1403; Chemistry 1303; two additional 3000 level or higher Math or Science courses with the approval of the student's adviser.	31
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381, and 5322.	53
Specialization:	EMIS 3308, EMIS 3309, CSE 4360 and ENCE 3302.	12
Advanced Major Electives:	Must be selected from 3000 level or higher ME courses with the approval of the student's adviser.	6
Wellness I and II		2
Minimum total hours required		125

Any deviation from the 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 major electives related to manufacturing engineering and manufacturing systems management. For details of the program, the student should consult the department.

Curriculum Notes

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

Curriculum Requirements		***TCH***
General Education:	English 1301, 1302, Perspectives and Cultural Formations Courses.	21
Mathematics and Sciences:	Math 1337, 1338, 2339, 2343 and Statistics 4340 or equivalent. Physics 1403, 1304; Chemistry 1303; two additional 3000 level or higher Math or Science courses with the approval of the student's adviser.	31
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4360, 4160, 4370, 4380, 4381, and 5322.	53
Manufacturing Electives:	Manufacturing electives must be approved by the student's adviser and must be selected from the following list: ME 5350, 5351, 5352, 5353, 5354, 5355, 5356, 5357, 5358, 5365, 5366, 5368, 5369, 5372, and 5391.	12
Leadership Electives:	Select two from EMIS 3308, EMIS 3309, ENCE 3302, or CSE 4360.	6
Wellness I and II:		2
Minimum total hours required		125

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
(Premedical/Biomedical Specialization)

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

Curriculum Notes

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

Curriculum Requirements		***TCH***
General Education:	English 1301, 1302, Perspectives and Cultural Formations courses.	21
Mathematics:	Math 1337, 1338, 2339, 2343, Statistics 4340.	15
Sciences:	Biology 1401, 1402, 3304, 3350; Chemistry 1303, 1113, 1304, 1114, 3371, 3117, 3372, 3118; Physics 1403, 1404.	38
Mechanical Engineering:	ME 1202, 1102, 1305, 2310, 2320, 2331, 2131, 2340, 2140, 2342, 2142, 3332, 3132, 3340, 3370, 4338, 4370, 4380, 4381, and 5322.	49
Advanced Major Elective:	ME 5332 or any 3000 level or higher ME course.	3
Leadership Elective:	Select one from EMIS 3308, EMIS 3309, ENCE 3302, or CSE 4360.	3
Wellness I and II:		2
Minimum total hours required		131

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 approval of a minor in Mechanical Engineering, the student should consult the department. A total of 15 semester hours in mechanical engineering courses is required. One example of an approved set of courses that provides a broad introduction to mechanical engineering is:

ME 1202 and **1102** Introduction to Engineering
ME 1301 Machines and Society
ME 2310 Statics
ME 3340 Engineering Materials
ME 3370 Manufacturing Processes

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

The Courses (ME)

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.

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

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

1372. Introduction to Computer Aided Engineering (CAE). Introduction to computer-aided drawing (Pro-Engineering and AutoCAD); symbolic mathematics (Mathematics); computer-based graphics (Excel and Kaleidagraph); and computer based data acquisition system (LabView).

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

2140. Mechanics of Materials Laboratory. Experiments in mechanics of deformable bodies, to complement ME 2340. Simple tension 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. *Prerequisite or corequisite:* ME 2340.

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. *Prerequisite or corequisite:* ME 2342.

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 2339.

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

2342. Fluid Mechanics. Fluid statics, fluid 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:* MATH 2339 and ME 2320.

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

3332. Heat and Mass Transfer. Fundamental principles of heat transmission by conduction, convection, and radiation; mass transfer; and application of these principles to the solution of engineering problems. *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. *Prerequisite:* CHEM 1305 or equivalent.

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

3350. Structural Engineering I: Analysis and Design in Steel. 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. *Prerequisites:* ME 2320, MATH 2343.

3370. Manufacturing Processes. 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. *Prerequisite:* ME 2340.

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

4338. Thermal Systems Design. Thermal systems designs are prepared, presented, and critiqued. Associated problems of simulation, optimization, and economics are solved. Solving problems and design with a thermal network analyzer is included. *Prerequisites:* ME 2331, ME 2342, and ME 3332.

4350. Structural Engineering II: Analysis and Design in Concrete. 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 modeling of mechanical systems. Mathematical models of linear systems. Solution of differential equations by use of Laplace transforms. Feedback control systems, time domain analysis, stability, frequency response, and root locus plots, Bode diagrams, performance criteria, and system compensation. Design of control systems for mechanical systems. *Prerequisite:* ME 5322 or equivalent.

4370. Elements of Mechanical Design. Application of the principles of mechanics and physical properties of materials to the proportioning of machine elements, including consideration of fatigue, functioning, productivity, and economic factors. Computer applications. *Prerequisite:* 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. Nontechnical considerations in design, including patents, ethics, aesthetics, safety, and economics are investigated. *Prerequisite or corequisite:* ME 3370.

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. *Prerequisite or corequisite:* ME 4370. *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. *Prerequisite:* ME 4360/EE 3370.

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 *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, MATH 2339, MATH 2343.

5321. Failure Analysis. A senior-graduate course in the evaluation of the failure of structural materials and components. Topics include: site examination, macroscopic examination, optical microscopy, transmission electron and SEM interpretation, examination and interpretation of failure surfaces, failure modes, causes of failure. *Prerequisites:* ME 3340 and ME 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. *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. *Prerequisite:* ME 3340.

5326. Vehicle Dynamics. Modeling of wheeled vehicles to predict performance, handling, and ride. Effects of vehicle center of mass, tire-characteristic traction and slip, engine characteristics, and gear ratios of performance. Suspension design and steady-state handling models of four-wheeled vehicles and car-trailer systems to determine oversteer and understeer characteristics, critical speeds, and stability. Multi-degree-of-freedom ride models including tire and suspension compliance. Computer animation and simulations. *Prerequisite:* ME 2320 or consent 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. *Prerequisite:* ME 3332 or equivalent.

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 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 2342, ME 3332 or consent of instructor.

5333. Transport Phenomena in Porous Media. Fundamental concepts of momentum, heat, and mass transport through heterogeneous (porous) materials, and implications on transport phenomena. Emphasis is placed on the mathematical modeling of heat and mass transfer in fully saturated systems. Relevant industrial applications are presented throughout the course. *Prerequisite:* ME 2331, ME 2342, ME 3332 or consent of instructor.

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 nonlinear model partial differential equations. Curvilinear grid generation. Advanced topics in grid generation. Beam and Warming factored implicit technique. MacCormack techniques. Solution methods for the Reynolds equation of lubrication, the boundary layer equations, and the Navier-Stokes equations. *Prerequisites:* ME 2342 (or equivalent), and MATH 2343 (or equivalent), or consent 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. Designed to develop an understanding of the structural aspect of solids and their relationship to properties and applications. Topics include structural defects, bonding and crystal structure, solid state reactions and phase transformations, degradation, and deformation. *Prerequisite:* ME 3340 or consent of instructor.

5342. Mechanical Engineering Aspects of Electronic Packaging. Intends to cover thermal and mechanical design of electronic packaging to include fundamentals of fluid flow, heat transfer, modern cooling technologies, and thermal management; mechanical designs including stress and vibrations covered through industrial applications; coupled thermal and mechanical problems; systems including selection of cooling methods and hardware important to good design; design of equipment that operates in severe vibration environments developed using classical methods.

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

5350. Design for Manufacturability 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 interrelationships 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. *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. *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. *Prerequisites:* ME 2340 and 3332, or permission of instructor.

5359. Analysis and Design of Optoelectronic Packaging. Provides an overview of optical fiber interconnections in telephone networks, packaging for high-density optical back planes, selection of fiber technologies; semiconductor laser and optical amplifier packaging, optical characteristics and requirements, electrical properties, mechanical properties, waveguide technologies, optical alignment and packaging approaches, passive device fabrication and packaging, array device packaging; hybrid technology for optoelectronic packaging, and flip-chip assembly for smart pixel arrays. *Prerequisites:* ME 5342 and 5343.

5360. Electronic Product Design and Reliability. Provides a complete description of the fundamentals of the design process for electronic products. Covers the obtaining of the voice of the customer through processes such as Quality Function Deployment. Analyzes the process of conceptual design. Carries the concept through the parametric and tolerance analysis. The design review process will be discussed as well as a review of the use of CAD tools for schematic capture and PWB layout. Reviews the use of modern tools for the maintenance of design documentation, the process of product realization through prototypes, manufacturing trials, and the introduction into high volume manufacturing. The impact of design choices on product quality and reliability will be discussed in detail as will the prediction and measurement of product lifetimes. *Prerequisites:* ME 5342 and ME 5343.

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.

5363. Electronic Manufacturing Technology. Covers the complete field of electronics manufacturing. Topics include an introduction to the electronics industry, electronic components, the theory and methods of manufacture of solid state devices, packaging techniques such as wire bonding flip chip and TAB, printed wiring board, soldering and solderability, leaded and surface mounted components, electromagnetic interference, electrostatic discharge prevention, testability and electronic stress screening. In each area, the current technology, as well as leading edge tools are discussed. *Prerequisites:* ME 5342 and ME 5343 or permission of instructor.

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

5366. Manufacturing in a Global Era. 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, linerarized two-dimensional flow method of characteristics, and oblique shocks. Design of air-breathing propulsion systems components: inlets, nozzles, compressors, turbines, and combustors. Interactions with the external flow. *Prerequisites:* ME 2342 and 3341.

5372. Introduction to CAD/CAM. Introduction to mechanical computer aided design. Survey of technical topics related to computer-aided design and computer-aided manufacturing. Emphasis on the use of interactive computer graphics in modeling, drafting, assembly, and analysis. Use of Pro-Engineer available, a state-of-the-art computer sided design system. *Prerequisites:* Junior standing or consent of instructor.

5376. Robotics – Introduction to Computer-Aided Manufacturing. Introduction to industrial robotics and numerically controlled machines. Economics of CAM. Applications or robotics in industry. Robot safety. Addition of senses and intelligence. Research in CAM Flexible manufacturing cells and systems. Hands-on laboratory work with industrial robots and NC machines. Independent study and report on a specific robot application. *Prerequisites:* 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. *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.

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

CENTER FOR SPECIAL STUDIES

The Special Studies designation is used to accommodate academic programs and courses that do not typically fit within the departments of the School of Engineering. Included under this section 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 Co-op Workterm. Each of these courses represents a term of industrial work activity in connection with the Engineering Cooperative Program. The courses are taken in numerical sequence and carry no credit. Students register for these courses in the same manner as 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.

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

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

LTC Wood, **Chair Department of Military Science (MILS), The University of Texas at Arlington**

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.

Army ROTC courses are not offered on the SMU campus. Instead, students participate in the Army ROTC program at the University of Texas at Arlington by enrolling in the ROTC courses listed below. Students who participate in the UTA Army ROTC program are responsible for their own travel and other physical arrangements. For more information, contact LTC Wood, chair, The Department of Military Science, College Hall, University of Texas at Arlington, Box 19005, 817-272-3281, www.armyrotc.uta.edu.

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 Degree Program requirements. Courses include:

ROTC 1180 Leadership Laboratory

ROTC 1141 Foundations of Leadership

ROTC 1142 Introduction to Leadership

ROTC 2248 Evolution of Contemporary Military Strategy

ROTC 2251 Individual/Team Development

ROTC 2252 Individual/Team Military Tactics

ROTC 2291 Conference Course

ROTC 2343 Leadership Training Camp

ROTC 3341 Leadership I

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Jay Majernik, *Part-time Staff Musician,* M.M., SMU
Jamal Mohamed, *Staff Musician,* Percussion Specialist
Mina Polevoy, *Part-time Staff Musician*
Edward Lee Smith, *Part-time Staff Musician,* Percussion Specialist
Janeen Vestal, *Part-time Staff Musician,* B.M., SMU

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Michael Dodds, *Assistant Professor of Music History,* Ph.D., Eastman School of Music
Donna Mayer-Martin, *Associate Professor of Music History,* Ph.D., University of Cincinnati College-Conservatory of Music
Carol Reynolds, *Associate Professor of Music History and Literature,* Ph.D., North Carolina (Chapel Hill)

Laurie Shulman, *Adjunct Professor of Music History*, Ph.D., Cornell University
Kay Holt, *Adjunct Lecturer*, Ph.D., University of Wyoming

Music Theory/Composition

Robert Frank, *Assistant Professor of Composition and Music Theory,* Ph.D., North Texas
Kevin Hanlon, *Associate Professor of Composition,* D.M.A., Texas (Austin)
David L. Mancini, *Associate Professor of Music Theory,* Ph.D., Yale
Simon Sargon, *Professor of Composition,* M.S., Juilliard School of Music
Martin Sweidel, *Associate Professor of Composition,* D.M.A., University of Cincinnati College-Conservatory of Music
Norman Wick, *Associate Professor of Music Theory and Director of Undergraduate Studies,* Ph.D., Wisconsin (Madison)

Music Therapy

Betsey Brunk, *Assistant Professor of Music Therapy*, M.M.T., SMU, MT-BC
Elizabeth Tober, *Adjunct Lecturer*, B.S., Western Illinois, B.M., SMU

Sacred Music

Kenneth W. Hart, *Professor,* D.M.A., University of Cincinnati College-Conservatory of Music
Michael Hawn, *Associate Professor, D.M.A.,* Southern Baptist Theological Seminary

Voice

Virginia Dupuy, *Associate Professor,* M.M., Texas (Austin)
Joan Heller, *Senior Lecturer and Head of Voice,* M.M., New England Conservatory
Louise Lerch, *Adjunct Lecturer,* M.M., University of Oklahoma, M.A., Texas Woman's University
Barbara H. Moore, *Professor of Music,* M.S., Illinois
Burr Phillips, *Assistant Professor,* M.M., Texas Christian University
Timothy Seelig, *Adjunct Assistant Professor,* D.M.A., North Texas

Division of Theatre

Rhonda Blair, *Professor of Theatre,* Ph.D., Kansas
Linda Blase, *Adjunct Lecturer,* M.F.A., Trinity
Carole Brandt, *Professor of Theatre,* Ph.D., Southern Illinois University
Michael Connolly, *Associate Professor of Theatre,* Ph.D., Indiana
James Crawford, *Visiting Assistant Professor of Theatre,* M.F.A., University of California (San Diego)
Christopher Edwards, *Master Electrician,* no degree
Eliseo Gutierrez, *Scene Shop Foreman,* no degree
Charles Helfert, *Associate Professor of Theatre,* Ph.D., Wisconsin
Kevin Paul Hofeditz, *Professor of Theatre,* M.F.A., Missouri (Kansas City)
Clay Houston, *Assistant Technical Director,* B.F.A., College of Santa Fe
Greg Leaming, *Associate Professor of Theatre,* M.F.A., Massachusetts (Amherst)
Steve Leary, *Technical Director,* B.A., Cameron
Bill Lengfelder, *Associate Professor of Theatre,* M.F.A., Lindenwood College
Cecil O'Neal, *Professor of Theatre,* B.A., Wisconsin
Russell Parkman, *Assistant Professor of Theatre,* M.A. (Certified in Mime), Illinois
Mercedes Rangel, *Stitcher,* no degree
Virginia Ness Ray, *Associate Professor of Theatre*, Professional Certificate with Prize, Royal Academy of Dramatic Art, London; Post-Graduate Certificate-Acting and Voice, Yale University

Melinda Robinson, *Draper/Cutter,* M.F.A., Southern California
Sara Romersberger, *Assistant Professor of Theatre,* M.A. (Certified in Mime), Illinois
Gretchen Smith, *Associate Professor of Theatre,* Ph.D., Indiana
Claudia Stephens, *Associate Professor of Theatre and Division Chair,* M.F.A., Carnegie Mellon
Giva Taylor, *Costume Shop Manager,* M.F.A., SMU
Kathy Windrow, *Adjunct Lecturer,* M.A., M.F.A., SMU
Steve Woods, *Assistant Professor of Theatre,* M.F.A., University of New Orleans

EMERITUS PROFESSORS

Robert T. Anderson, *University Distinguished Professor of Organ and Sacred Music, 1981-82 Meadows Foundation Distinguished Teaching Professor,* D.S.M., Union Theological Seminary
Robert Beard, *Associate Professor Emeritus of Dance,* M.F.A., SMU
Robert B. Chambers, *Associate Professor Emeritus of Stage Design,* M.A., Kansas
Harris Crohn, *Associate Professor Emeritus of Piano,* D.M.A., Eastern School of Music
Charles Eagle, *Professor Emeritus of Music Therapy*
Eugene Ellsworth, *Professor Emeritus of Music*
Elizabeth A. Ferguson, *Professor Emerita of Dance, 1985-86 Meadows Foundation Distinguished Teaching Professor,* M.F.A., SMU
John Gartley, *Professor Emeritus of Cinema,* Ph.D., Michigan
Peggy Harrison, *Professor Emerita of Communication Disorders*
Mesrop Kesdekian, *Professor Emeritus of Theatre,* M.A., Penn State
Lois B. Land, *Professor Emerita of Music*
Bob R. Leonard, *Professor Emeritus of Theatre,* Ph.D., Kansas
John McElroy, *Professor Emeritus of Art*, M.S., Florida State
David McHam, *Professor Emeritus of Communications, 1995-96 Meadows Foundation Distinguished Teaching Professor,* M.S., Columbia
Dale Moffitt, *Associate Professor of Theatre, 1991-92 Meadows Foundation Distinguished Teaching Professor,* Ph.D., Washington State
Jim Morris, *Associate Professor Emeritus of Communications,* Ed.D., North Texas
Louise D. Mueller, *Professor Emerita of Music Theory,* M.M., Eastman School
G. Donald Pasquella, *Associate Professor Emeritus of Communications,* M.A., Iowa
Darwin Payne, *Professor Emeritus of Communications,* Ph.D., Texas (Austin)
Martin S. Reese, *Professor Emeritus of Communications*
Wilbert Verhelst, *Professor Emeritus of Art*, M.A., University of Denver
Harold Weiss, *Professor Emeritus of Speech*
Stephen D. Wilder, *Professor Emeritus of Art*, M.F.A., Wisconsin

School of Engineering

ADMINISTRATION

Geoffrey C. Orsak, Ph.D., *Dean*
James G. Dunham, Ph.D., *Associate Dean*
To be announced, *Assistant Dean, Operations*
Leo Pucacco, Ph.D., *Assistant Dean, Undergraduate Studies*
Richard S. Barr, Ph.D., *Chair, Engineering Management, Information, and Systems*
Hesham El-Rewini, Ph.D., *Chair, Department of Computer Science and Engineering*
Bijan Mohraz, Ph.D., *Chair, Department of Environmental and Civil Engineering*
Panos Papamichalis, Ph.D., *Chair, Department of Electrical Engineering*
Yildirim Hürmüzlü, Ph.D., *Chair, Department of Mechanical Engineering*
Andy Winstel, B.B.A., *Financial Officer and Administrative Director*
Michael Acosta, M.P.A., *Director, Enrollment Management and Student Development*
Misti Compton, *Executive Assistant to the Dean*

RESIDENT FACULTY

Alfredo Armendariz, *Assistant Professor of Environmental and Civil Engineering,* Ph.D., North Carolina

H. Charles Baker, P.E., *Senior Lecturer of Electrical Engineering,* Ph.D., Texas (Austin)

Richard S. Barr, *Associate Professor of Engineering Management, Information, and Systems,* Ph.D., Texas (Austin)

Jerome K. Butler, P.E., *University Distinguished Professor of Electrical Engineering,* Ph.D., Kansas

Thomas Chen, *Associate Professor of Electrical Engineering and Associate Professor of Computer Science and Engineering,* Ph.D., California (Berkeley)

Frank Coyle, *Senior Lecturer of Computer Science and Engineering,* Ph.D., SMU

Marc P. Christensen, *Assistant Professor of Electrical Engineering,* Ph.D., George Mason

Carlos E. Davila, *Associate Professor of Electrical Engineering,* Ph.D., Texas (Austin)

Roger O. Dickey, P.E., *Senior Lecturer of Environmental and Civil Engineering,* Ph.D., SMU

Scott C. Douglas, *Associate Professor of Electrical Engineering,* Ph.D., Stanford

James G. Dunham, P.E., *Associate Professor of Electrical Engineering and Associate Professor of Computer Science and Engineering,* Ph.D., Stanford

Margaret H. Dunham, *Professor of Computer Science and Engineering,* Ph.D., SMU

John H. Easton, *Assistant Professor of Environmental and Civil Engineering,* Ph.D., Alabama

Hesham El-Rewini, *Professor of Computer Science and Engineering,* Ph.D., Oregon State

Judy Etchison, *Lecturer of Computer Science and Engineering*, M.S., Texas A&M, Commerce

Donald E. Evans, *Lecturer of Computer Science and Engineering,* D.M.A., North Texas

Gary Evans, P.E., *Professor of Electrical Engineering,* Ph.D., California Institute of Technology

W. Milton Gosney, P.E., *Cecil and Ida Green Professor of Electrical Engineering,* Ph.D., California (Berkeley)

Gemunu S. Happawana, *Assistant Professor of Mechanical Engineering,* Ph.D., Purdue

Richard V. Helgason, *Associate Professor of Engineering Management, Information, and Systems, and Associate Professor of Computer Science and Engineering,* Ph.D., SMU
Jack P. Holman, P.E., *Brown Foundation Professor of Mechanical Engineering,* Ph.D., Oklahoma State
Yildirim Hürmüzlü, *Professor of Mechanical Engineering,* Ph.D., Drexel
David B. Johnson, P.E., *Professor of Mechanical Engineering,* Ph.D., Stanford
Jeffery L. Kennington, P.E., *Professor of Engineering Management, Information, and Systems,* Ph.D., Georgia Institute of Technology
Alireza Khotanzad, P.E., *Professor of Electrical Engineering,* Ph.D., Purdue
Fatih Kocan, *Assistant Professor of Computer Science and Engineering,* Ph.D., Case Western Reserve
Radovan Kovacevic, *Herman Brown Chair Professor of Mechanical Engineering,* Ph.D., University of Montenegro
Paul Krueger, *Assistant Professor of Mechanical Engineering, and Assistant Professor of Environmental and Civil Engineering,* Ph.D., California Institute of Technology
José Lage, *Professor of Mechanical Engineering, and Professor of Environmental and Civil Engineering*, Ph.D., Duke
Choon S. Lee, *Associate Professor of Electrical Engineering,* Ph.D., Illinois (Urbana)
Mary Alys Lillard, *Lecturer of Engineering Management, Information, and Systems,* M.S., SMU
Charles M. Lovas, P.E., *Associate Professor of Mechanical Engineering,* Ph.D., Notre Dame
David W. Matula, *Professor of Computer Science and Engineering,* Ph.D., California (Berkeley)
Saadeddine Mneimneh, *Assistant Professor of Computer Science and Engineering,* Ph.D., MIT
Bijan Mohraz, P.E., *Professor of Environmental and Civil Engineering, and Professor of Mechanical Engineering,* Ph.D., Illinois (Urbana)
Dona Mularkey, *Lecturer of Mechanical Engineering,* Ph.D., Vanderbilt
Sukumaran Nair, *Associate Professor of Computer Science and Engineering, and Associate Professor of Electrical Engineering,* Ph.D., Illinois (Urbana)
Eli V. Olinick, *Assistant Professor of Engineering Management, Information, and Systems,* Ph.D., California (Berkeley)
Geoffrey C. Orsak, *Professor of Electrical Engineering,* Ph.D., Rice
Panos Papamichalis, *Professor of Electrical Engineering,* Ph.D., Georgia Institute of Technology
Behrouz Peikari, P.E., *Professor of Electrical Engineering,* Ph.D., California (Berkeley)
Peter E. Raad, P.E., *Professor of Mechanical Engineering,* Ph.D., Tennessee (Knoxville)
Dinesh Rajan, *Assistant Professor of Electrical Engineering,* Ph.D., Rice
Peter-Michael Seidel, *Assistant Professor of Computer Science and Engineering,* Ph.D., University of Saarland, Germany
Thomas Siems, *Senior Lecturer of Engineering Management, Information, and Systems*, Ph.D., SMU
Mandyam D. Srinath, P.E., *Professor of Electrical Engineering,* Ph.D., Illinois (Urbana)

Jerrell R. Stracener, *Scholar in Residence of Engineering Management, Information, and Systems,* Ph.D., SMU

Stephen A. Szygenda, *Cecil H. Green Chair Professor of Computer Science and Engineering, and Cecil H. Green Chair Professor of Engineering Management, Information, and Systems,* Ph.D., Northwestern

Mitchell A. Thornton, *Associate Professor of Computer Science and Engineering, and Associate Professor of Electrical Engineering,* Ph.D., SMU

Jeff Tian, *Associate Professor of Computer Science and Engineering,* Ph.D., Maryland

David A. Willis, *Assistant Professor of Mechanical Engineering, and Assistant Professor of Environmental and Civil Engineering,* Ph.D., Purdue

EMERITUS FACULTY

Kenneth L. Ashley, P.E., *Professor Emeritus of Electrical Engineering,* Ph.D., Carnegie Mellon

Charles E. Balleisen, P.E., *Professor Emeritus of Mechanical Engineering,* M.S.M.E., MIT

Robert R. Fossum, *Professor Emeritus of Electrical Engineering,* Ph.D., Oregon State

Someshwar C. Gupta, P.E., *Professor Emeritus of Electrical Engineering,* Ph.D., California (Berkeley)

Kenneth W. Heizer, P.E., *Professor Emeritus of Electrical Engineering,* Ph.D., Illinois (Urbana)

Lorn L. Howard, P.E., *Professor Emeritus of Electrical Engineering,* Ph.D., Michigan State

Paul F. Packman, P.E., *Professor Emeritus of Mechanical Engineering,* Ph.D., Syracuse

John A. Savage, P.E., *Professor Emeritus of Electrical Engineering,* M.S.E.E., Texas (Austin)

Cecil H. Smith, P.E., *Professor Emeritus of Mechanical Engineering,* Ph.D., Texas (Austin)

Hal Watson Jr., P.E, *Professor Emeritus of Mechanical Engineering,* Ph.D., Texas (Austin)

Edmund E. Weynand, *Professor Emeritus of Mechanical Engineering,* Sc.D., MIT

ADJUNCT FACULTY

Bogdan Antohe, *Adjunct Associate Professor of Mechanical Engineering,* Ph.D., SMU (MicroFab)

Karl Arunski, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* M.S.E.E., Washington University (Raytheon)

Leslie-Ann Asmus, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* Ph.D., George Mason University

John Barber, *Adjunct Assistant Professor of Environmental and Civil Engineering*. Ph.D., Indiana University of Pennsylvania (University of Texas at Dallas)

Terry V. Baughn, P.E., *Adjunct Associate Professor of Mechanical Engineering,* Ph.D., Delaware

William David Bell, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* D.E., SMU (U.S. Defense Department)

Arthur Beck, P.E., *Adjunct Assistant Professor of Environmental and Civil Engineering,* M.S., SMU (BSM Engineers)

Eric Bird, *Adjunct Assistant Professor of Electrical Engineering,* M.S., SMU (Ericsson)

Elena Borzova, *Adjunct Assistant Professor of Mechanical Engineering, and Adjunct Assistant Professor of Environmental and Civil Engineering,* Ph.D., SMU
Mark K. Boyd, P.E., *Adjunct Assistant Professor of Environmental and Civil Engineering*, Ph.D., SMU (LCA Environmental)
William A. Bralick Jr., *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., Pennsylvania State (Texas Instruments)
Ann E. Broihier, *Adjunct Lecturer of Computer Science and Engineering,* M.S., Northern Illinois (Raytheon)
Hakki Candan Cankaya, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., SMU (Alcatel)
Gerald R. Carney, *Adjunct Associate Professor of Environmental and Civil Engineering,* Ph.D., North Texas (U.S. Environmental Protection Agency)
Michael Cassidy, *Adjunct Professor of Mechanical Engineering,* Ph.D., Illinois (Lucent Technologies)
Cheng-Chung Chen, *Adjunct Assistant Professor of Electrical Engineering,* Ph.D., Florida (NEC)
Joseph H. Dean, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* Ph.D., Texas A&M (Lockheed Martin)
James Duke, P.E., *Adjunct Associate Professor of Environmental and Civil Engineering,* Ph.D., Colorado State University
Ted Dumas, *Adjunct Professor of Environmental and Civil Engineering, and Adjunct Professor of Mechanical Engineering*, M.S.C.E., SMU
Carl Edlund, P.E., *Adjunct Associate Professor of Environmental and Civil Engineering,* B.S.M.E., University of Maryland
Fawzi Elghadamsi, P.E., *Adjunct Assistant Professor of Environmental and Civil Engineering, and Adjunct Assistant Professor of Mechanical Engineering*, Ph.D., SMU (Lockwood Greene)
Mark Fontenot, *Adjunct Professor of Computer Science and Engineering*, M.S.C.S., SMU
Edward Forest, *Retired Chair of Environmental and Civil Engineering,* Ph.D., Princeton
Dennis Frailey, *Adjunct Professor of Computer Science and Engineering, and Adjunct Professor of Engineering Management, Information, and Systems,* Ph.D., Purdue (Raytheon)
Regina Gaiotti, *Adjunct Associate Professor of Mechanical Engineering, and Adjunct Associate Professor of Environmental and Civil Engineering,* Ph.D., McGill
Jerry Gannaway, *Adjunct Associate Professor of Mechanical Engineering,* D.E., SMU (Lockheed Martin)
Ryan M. Garlick, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* Ph.D., SMU
Ramon Goforth, *Adjunct Professor of Mechanical Engineering,* Ph.D., Texas (Arlington)
Steven Gray, *Adjunct Professor of Electrical Engineering,* Ph.D., Northeastern (Nokia)
Bill L. Gunnin, P.E., *Adjunct Assistant Professor of Environmental and Civil Engineering,* Ph.D., Texas (Austin) (Gunnin Consulting)
Dale Gutt, *Adjunct Lecturer of Computer Science and Engineering,* M.S., SMU
Ganesh L. Harpavat, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* Ph.D., University of Rochester (Lucent Technologies)
James Hinderer, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* Ph.D., (Raytheon)

Anwar Hirany, P.E., *Adjunct Assistant Professor of Environmental and Civil Engineering, and Adjunct Assistant Professor of Mechanical Engineering,* Ph.D., Cornell (ESPRI)

Hossam H'mimy, *Adjunct Associate Professor of Electrical Engineering,* Ph.D., SMU (Ericsson)

Louis Hosek, *Adjunct Assistant Professor of Environmental and Civil Engineering*, Ph.D., Oklahoma (American Electric Power)

Gerard Ibarra, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* M.S., SMU (Business Courier Services)

Raji Josiam, *Adjunct Assistant Professor of Environmental and Civil Engineering*, M.S.C.E., Texas A&M (U.S. Environmental Protection Agency)

G. Neelakantan Kartha, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., Texas

Kamran Z. Khan, *Adjunct Lecturer of Computer Science and Engineering,* M.S., UTD (MCI WorldCom)

Mohamed Khalil, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., New Mexico State

Clark Kinnaird, P.E., *Adjunct Associate Professor of Electrical Engineering,* Ph.D., SMU (Texas Instruments)

Bernard Ku, *Adjunct Associate Professor of Electrical Engineering*, Ph.D., SMU (MCI Telecommunications)

James E. Langford, *Adjunct Assistant Professor of Environmental and Civil Engineering*, M.Arch., Harvard (James E. Langford, Architects and Planners, L.L.C.)

Chantale Laurent-Rice, *Adjunct Lecturer of Computer Science and Engineering,* M.S., SMU

Craig L. Lee, *Adjunct Professor of Mechanical Engineering,* Ph.D., SMU (Raytheon)

Donald L. Legg, P.E., *Adjunct Associate Professor of Environmental and Civil Engineering,* M.S.S.M., University of Akron (Bell Helicopter)

Eric O. Lentz, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* M.E., Harvard (Tatum CIO Partners)

Richard Levine, P.E., *Adjunct Professor of Electrical Engineering,* Ph.D., MIT (Beta Scientific Laboratory)

Babu V. Mani, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., Nova Southeastern (Alcatel)

Paul Martin, P.E., *Adjunct Assistant Professor of Environmental and Civil Engineering,* M.S., Nebraska

Lee McFearin, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., SMU (Alcatel)

Gretchen Miller, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* M.B.A., Texas (Arlington)

Riad A.K. Mohamed, *Adjunct Assistant Professor of Computer Science and Engineering*, Ph.D., SMU (Sabre Decision Technologies)

Freeman L. Moore, *Adjunct Assistant Professor of Computer Science and Engineering*, Ph.D., North Texas (Raytheon Systems Co.)

David Nowacki, *Adjunct Assistant Professor of Mechanical Engineering,* Texas (Dallas)

Augustyn Ortynski, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* Ph.D., SMU (Nortel)

Robert S. Oshana, *Adjunct Lecturer of Computer Science and Engineering,* M.S., SMU (ObjectSpace Inc.)
Marius Pasca, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., SMU (Language Computer Corporation)
Paul F. Packman, P.E., *Adjunct Professor of Mechanical Engineering,* Ph.D., Syracuse
Girish Patel, *Adjunct Assistant Professor of Electrical Engineering,* Ph.D., Georgia Institute of Technology (Microtune)
David Peters, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* B.B.A., SMU
Albert Petrasek, *Adjunct Associate Professor of Mechanical Engineering,* Ph.D., Texas A&M (Albert Halff and Associates)
John J. Pfister, *Adjunct Assistant Professor of Computer Science and Engineering,* M.C.S., Texas A&M (Texas Instruments)
Oscar K. Pickels, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* M.B.A., SMU
Krishnakumar Pillai, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., SMU (Nortel Networks)
Rod Pipinich, *Adjunct Associate Professor of Mechanical Engineering,* Ph.D., SMU (Lockheed Martin)
Donald C. Price, *Adjunct Professor of Mechanical Engineering,* Ph.D., Oklahoma State (Raytheon)
John D. Provence, P.E., *Adjunct Associate Professor of Electrical Engineering,* Ph.D., SMU (Honeywell)
Leo R. Pucacco, *Adjunct Assistant Professor of Electrical Engineering,* Ph.D., SMU
K.S. Rajagopalan, P.E., *Adjunct Professor of Environmental and Civil Engineering, and Adjunct Professor of Mechanical Engineering,* Ph.D., Texas (Austin) (Technistructures)
P.K. Rajasekaran, P.E., *Adjunct Professor of Electrical Engineering,* Ph.D., SMU
Natarajan Ramanan, *Adjunct Assistant Professor of Mechanical Engineering,* Ph.D., Ohio State (FSI International)
Jon D. Rauscher, *Adjunct Associate Professor of Environmental and Civil Engineering,* Ph.D., Colorado State University (U.S. Environmental Protection Agency)
Mohamed Omar Rayes, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., Kent State
Alfred Riccomi, *Adjunct Lecturer of Computer Science and Engineering,* B.S., Illinois (Multimedia PC Systems)
Edmond Richer, *Adjunct Assistant Professor of Mechanical Engineering,* Ph.D., SMU (U.T. Southwestern)
Steven Sanazaro, *Adjunct Assistant Professor of Engineering Management, Information, and Systems*, M.A., University of Illinois-Champaign (Tatum CIO Partners)
Roshan L. Sharma, *Adjunct Associate Professor of Electrical Engineering,* M.S. (Physics), Southern California (Telecom Network Science)
Gordon Sohl, *Adjunct Assistant Professor of Electrical Engineering,* B.S., Minnesota (Abbott Laboratories)
Gheorghe Spiride, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* Ph.D., SMU (Nortel Networks)
D. Blair Spitzberg, *Adjunct Associate Professor of Environmental and Civil Engineering,* Ph.D., Texas (U.S. Nuclear Regulatory Commission)

Wendy Spring, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* M.B.A., Texas (Arlington)

John Stanley, *Adjunct Assistant Professor of Environmental and Civil Engineering*, M.S. (Engineering Management), SMU (FACServices Inc.)

Stephen L. Stepoway, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., Texas (Dallas)

Bennett Stokes, *Adjunct Associate Professor of Environmental and Civil Engineering,* J.D., Texas (Austin)

William Swanson, *Adjunct Assistant Professor of Engineering Management, Information, and Systems,* B.S., Texas A&M

Ken Thomas, *Adjunct Assistant Professor of Environmental and Civil Engineering*, M.S. (Human Relations and Business), Amberton University (Fisher Controls)

Jim Veach, *Adjunct Assistant Professor of Environmental and Civil Engineering,* J.D., SMU (Fina Oil & Chemical Co.)

Greg Wilson, P.E., *Adjunct Assistant Professor of Environmental and Civil Engineering,* Ph.D., Arizona State (psi)

James Wilson, *Adjunct Associate Professor of Mechanical Engineering,* Ph.D., SMU (Raytheon)

Chris Witzke, *Adjunct Associate Professor of Mechanical Engineering,* M.S.E.E., SMU (Marlow Industries)

Scott Woodrow, P.E., *Adjunct Assistant Professor of Environmental and Civil Engineering*, M.S. (Hazardous and Waste Materials Management), SMU (Atmel Corporation)

John Yarrow, *Adjunct Assistant Professor of Engineering Management, Information, and Systems*, M.S., University of North Texas (Southwest Airlines)

Hossam Zaki, *Adjunct Professor of Engineering Management, Information, and Systems,* Ph.D., SMU

Yanjun Zhang, *Adjunct Assistant Professor of Computer Science and Engineering,* Ph.D., University of California-Berkeley (Sabre Decision Technologies)

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