LYLE SCHOOL OF ENGINEERING

GENERAL INFORMATION

The Lyle School of Engineering, named in2008 in honor of Dallas entrepreneur and industry leader Bobby B. Lyle, traces its roots to 1925, when the Technical Club of Dallas, a professional organization of practicing engineers, petitioned SMU to fulfill the need for an engineering school in the Southwest. In response to the club's request, the school began one of the first cooperative education programs in the United States, a program that continues today to put engineering students to work on real technical projects.

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

The Dallas area's national prominence in high technology and research has been beneficial to the Lyle School of Engineering and its students. Corporate support for the Lyle School has generated a remarkable array of equipment and laboratories. Recent additions include the AT&T Mixed Signals Lab, the Texas Instruments Digital Signal Processing Lab, the Procter and Gamble Biomedical Research Lab, and the Nokia Wireless Communication Lab. Other laboratories include the Laser Micromachining Lab, the Nanoscale Electro-thermal Science Lab and the Enterprise Systems Design Laboratory. In addition, the Lyle School is the home of the following facilities:

Research Center for Advanced Manufacturing. RCAM provides the intellectual foundation for industry to collaborate with faculty and students to resolve generic, long-range challenges, thereby producing the knowledge base for steady advances in technology and their speedy transition to the marketplace.

Center for Laser-aided Manufacturing. CLAM addresses a number of research and development issues related to laser-aided intelligent manufacturing processes.

Center for Lasers and Plasma s for Advanced Manufacturing. The center conducts research of interest to the industry and SMU as part of a multi-university team and with support from the Industry and University Cooperative Research Centers Program of the National Science Foundation.

National Science Foundation Industrial /University Coope ration Research Center for Net-Centric Software and System. The Center for Net-Centric Software and Systems addresses fundamental software and systems research for the modeling, analysis, design, implementation, testing, deployment and evolution of net-centric and embedded systems.

Defense Advanced Research Projects Agency Neurophotonics Research Center. The Neurophotonics Research Center seeks to develop two-way fiber optic

Professional Engineering Licensure

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

Program Information

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

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

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

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

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

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

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

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

Undergraduate Engineering Internship Program

This program is intended to allow students who enroll as full-time students to include a minimum of three terms of professional work experience during their studw BT e(TD -.000m5s.tud03.42 -0s.2(d)-1.8ehTw [(e7)]TJ 18. 87oape)9.4(p)togieringE arinj.8

load shall not work more than a maximum of 20 hours a week. Students who are actively participating in a full-time work experience shall not enroll in more than nine credit hours per term. Zero hours of credit will be awarded for each term of internship. Participation in this program will not jeopardize the full-time status of international students. Students who wish to participate in this program need to

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

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

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

COOPERATIVE EDUCATION

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

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

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

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

How the Cooperative Program Operates

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

balances the student's individual needs with the long-term goal of maintaining the program's corporate relationships for future SMU students.

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

- Students must maintain good standing with SMU and their employer at all times.
- All training jobs must be approved in advance by the SMU Co-op Program associate director.
- Before each work term begins, undergraduate students in the program must enroll in the appropriate program course for the term when they work.
- SMU charges no fees or tuition for these courses. Each course is graded on a pass/fail basis by the program's associate director. The courses do not count toward graduation. The course numbers for each work term are, respectively, SS 1099, 2099, 3099, 4099, 5099, 6099.
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High School Preparation

Because of the high standards of the Lyle School of Engineering and the rigorous character of its curricula, it is essential that the entering student be well prepared in basic academic subjects in high school. To be successful in SMU engineering programs, the student should have the following academic strengths:

1. Enrollment in an appropriate program of study in high school.
2. Rank in the upper third of his or her graduating high school class.
3. A minimum SAT composite score of

Admission by Transfer From Another Institution

Prospective transfer students interested in undergraduate degrees in engineering apply for undergraduate admission to SMU through the Office of Admissions, Southern Methodist University, PO Box 750181, Dallas TX 75275-0181. An undergraduate at a junior college, college or university may apply for transfer admission to SMU and the Lyle School of Engineering. Admission will be granted provided the prior academic records and reasons for transfer are acceptable to the Lyle School of Engineering. Transfer credit will be awarded in courses that have identifiable counterparts in curricula of the Ly le School of Engineering, provided they carry grades of *C*- or better. Transfer students will be expected to meet requirements equivalent to students admitted from Dedman College and other schools within SMU.

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Departmental Distinction Program

Upon successful completion of a special program of study, students will be awarded departmental distinction by their major department, regardless of their eligibility for Latin graduation honors or for graduation honors in the liberal arts. The special program of study is undertaken in both the junior and senior years, and it requires independent reading and research beyondthe regular departmental requirements for a degree. This award is conferred by the major department on the basis of certain criteria prescribed by the department, but all programs include the following requirements:

- A major GPA of 3.500 or higher.
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Engineering work can be classified by function, regardless of the branch, as follows: research, development, design, production, testing, planning, sales, service, construction, operation, teaching, consulting and management. The function fulfilled by an engineer results in large measure from personal characteristics and motivations, and only partially from his or her curriculum of study. Nonetheless, while engineering curricula may be relatively uniform, the modes of presentation tend to point a student toward a particular large class of functions. Engineering curricula at SMU aim generally at engineering functions that include research, development, design, management and teaching – functions ordinarily associated with additional education beyond the Bachelor's degree.

The Lyle School of Engineering undergraduate programs in civil engineering, computer engineering, electrical engineering, environmental engineering and mechanical engineering are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The undergraduate computer science program that awards the degree Bachelor of Science (B.S.) is accredited by the Computing

Civil and Environmental Engineering

Associate Professor Khaled F. Abdelghany, Chair

Professors: Paul S. Krueger (Mechanical Engineering), Bijan Mohraz. Associate Professors:

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

1. Assume important leadership positions in a globally competitive world.
2. Fully participate either as engineering designers or as managers in the public

Degrees Offered

The CEE Department offers undergraduate degrees as follows:

Bachelor of Science in Civil Engineering
Bachelor of Science in Civil Engineering and Bachelor of Science with a major in mathematics (dual degrees)
Bachelor of Science in Environmental Engineering
Bachelor of Science in Environmental Engineering and Bachelor of Science with a major in mathematics (dual degrees)
Bachelor of Science in Environmental Engineering with a premedical specialization

The Engineering Accreditation Commission of ABET, http://www.abet.org, has accredited the undergraduate programs in civil engineering and environmental engineering.

Both the civil and environmental engineering programs are designed to prepare students for the Fundamentals of Engineering Examination, the first step toward licensure as a professional engineer. Engineering design is integrated throughout the civil and environmental engineering curricula, each culminating in a major design experience based on the knowledge and skills acquired in earlier coursework. In their senior year, the department's engineering students are required to take two terms of design where teams of two to four students work closely on practical projects sponsored by industry and goE9(l)-8(dustr.34 Tw (ud)4.9(ement)9 w (ud)92)1( )u.4(ent)9y

Bachelor of Science in Environmental Engineering

(Premedical Specialization)

Curriculum Notes. In addition to the University-wide requirements, which include the completion of a minimum of 120 academic credit hours for any degree, the term credit hours within this curriculum are distributed as follows:

Requirements for the Specialization	*Credit Hours*
Mathematics and Science	56
MATH 1337, 1338, 2339, 2343 STAT 4340 *or* 5340 BIOL 1401, 1402, 3304, 3350 CEE 1331 CHEM 1303/1113, 1304/1114, 3371/3117, 3372/3118 PHYS 1303/1105, 1304/1106	
Engineering Science and Design	12
CEE 2310, 2331, 2342, 3310	
Environmental Engineering and Design	36
CEE 1302, 2304, 2372, 2421, 3323, 3341, 3431, 3451, 4380, 4381, 5354	
Environmental Technical Electives	6
Selected with adviser's approval.	
	110

Minor in Civil Engineering

For approval of a minor in civil engineering, the student should consult the Civil and Environmental Engineering Department. A minimum of 15 term credit hours in civil engineering courses are required. The following is an example of an approved set of courses, totaling 16 term credit hours, that provides an emphasis on structural analysis and design: CEE 2310, 2340/2140, 3350, 3385, 4350.

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

Minor in Environmental Engineering

For approval of a minor in environmental engineering, the student should consult the Civil and Environmental Engineering Department. A minimum of 15 term credit hours in environmental engineering courses are required. The following is an example of an approved set of courses that provides a broad introduction to environmental engineering: CEE 2304, 2421, 3431, 4329, 5354. Based on the student's interests and background, other sets of environmental engineering courses may be substituted with the approval of the Civil and Environmental Engineering Department.

Minor in Global Development

Students may earn a minor in global development through the Civil and Environmental Engineering Department, supported by the Hunter and Stephanie Hunt Institute for Engineering and Humanity. A total of 18 term credit hours are required, with a minimum of six term credit hours at or above the 3000 level. All students are

required to complete the introductory course CEE 1326. A depth component of six term credit hours must be completed in one of the following concentration areas:

Environmental Resources:	CEE 2304, 2421, 3323, 3341, 3353, 5321, 5322
Political, Cultural and Economic Issues:	EMIS 3309; CEE 3355, 5311, 5325, 5328
Technology and Innovation:	CEE 1302; ME 1303; CEE 5327, 5329–30, 5378, 5384

water pollution are examined, emphasis is placed on contemporary topics such as hazardous waste, risk assessment, groundwater contamination, global climate change, stratospheric ozone depletion, and acid deposition. Where appropriate, pertinent environmental legislation is described, engineering models are derived and applied, and treatment technologies introduced. *Prerequisites:* CHEM 1303 and MATH 1338.

CEE 2310/ME 2310 (3). STATICS. Equilibrium of force systems; computations of reactions and internal forces; determinations

analysis and extreme value theory for determination of flood and drought hazard. Interpretation and statistical analysis of climatologic,

climate change, and stratospheric ozone depletion. *Prerequisites:* CHEM 1303, MATH 1337 or equivalent, PHYS 1303 or equivalent.

CEE 3451 (4). INDUSTRIAL HYGIENE AND OCCUPATIONAL HEALTH. The recognition, evaluation, and control of health hazards in the working environment are presented. Principles of industrial toxicology, risk assessment/management, occupational diseases, and occupational health standards are examined. The application of industrial hygiene principles and practice as well as the measurement and control of atmospheric contaminants are presented. The design and evaluation of occupational exposure controls are introduced. Lecture and three hours of laboratory. *Prerequisite:* CHEM 1304.

CEE 4329 (3). DESIGN OF WATER AND WASTEWATER SYSTEMS. Covers physical, chemical, and biological concepts and processes that are specific to public water supplies and municipal wastewater management. Reviews fluid mechanics and introduces 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. *Prerequisite:* CHEM 1303, CEE 2304 and CEE/ME 2342.

CEE 4333 (3). FUNDAMENTALS OF AIR QUALITY II. Fundamental and advanced topics in air quality are covered, building upon CEE 3431. Atmospheric dispersion of pollutants is

CEE 5191 (1), 5192 (1), 5291 (2), 5292 (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.

CEE 5311 (3). ENVIRONMENTAL AND HAZARDOUS WASTE LAWS. Federal environmental laws, with emphasis on laws dealing with hazardous substances, such as CERCLA and RCRA; regulations and the regulatory framework; definitions and substantive requirements; roles of the States and the Federal EPA; compliance and enforcement; case studies.

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

CEE 5313 (3). ENVIRONMENTAL CHEMISTRY AND BIOLOGY. Chemical and biochemical processes; controlling fate and transport of hazardous materials with emphasis on chemical equilibria; chemical thermodynamics; acid-base equilibria; precipitation and dissolution;

CEE 5325 (3). DISASTER MANAGEMENT. This course introduces the student to basic concepts in disaster management Drawing on a range of sources from the textbook to the U.S. National Response plan to research papers, the course covers the fundamentals of preparedness, mitigation, response, and recovery. An all-hazards approach is taken, providing analysis of natural, technological, and man-made disasters. In addition to discussing the basic theories of disaster management, the course introduces thestudent to key methods in the field, including simulation modeling, consequence analysis tools, design criteria, statistical and case study methods (lessons learned), and risk analysis.

CEE 5327 (3). OPTIMIZATION AND RELIABILITY FOR INFRASTRUCTURE AND ENVIRONMENTAL SYSTEMS. Introduces the concepts of engineering systems optimization, reliability and risk assessment, and applies them to civil and environmental engineering systems. Includes an introduction to engineering systems definition, classical methods of optimization, linear programming, integer programming, dynamic programming, nonlinear optimization, and reliability and risk concepts in engineering planning and design. Engineering applications include transportation networks , fleet assignment, supply chain management,

measurement, and analysis. The course emphasizes the origins and properties of atmospheric aerosols and the design of air pollution control equipment. *Prerequisite:* CEE 3431 or CEE/ME 2342 or equivalent.

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

CEE 5365 (3). INTRODUCTION TO CONSTRUCTION MANAGEMENT. Construction practice techniques and current technological tools are examined. Included are cost estimating, bidding,

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

CEE 5383 (3). HEATING, VENTILATING, AND AIR CONDITIONING. Examines the science and practice of controlling environmental conditions through the use of thermal process and systems. Specific applications include refrigeration, psychometrics, solar radiation, heating and cooling loads in buildings, and design of duct and piping systems. Theory and analysis are emphasized. *Prerequisite:* CEE/ME 2331, CEE 2342, and ME 3332.

CEE 5384 (3). ENERGY MANAGEMENT FOR BUILDINGS. Procedures to select energy savings options for buildings are examined with emphasis on the practical aspects of the subject. Space planning, architectural considerations, cost, and environmental impact of the mechanical and electrical systems are considered along with optimizing the life cycle cost of the proposed alternative. Software for life-cycle cost and energy analysis is used to calculate energy consumption and compare energy features of proposed, audit-determined feasible changes to a building.

CEE 5385 (3). ADVANCED SOIL MECHANICS. Physicochemical properties of soil and soil

Computer Science and Engineering

Professor Sukumaran V.S. Nair, Chair

Professors: Delores M. Etter (Electrical Engineering), David W. Matula, Sukumaran V.S. Nair, Stephen A. Szygenda, Mitchell A. Thornton, Jeff Tian. Associate Professors: James G. Dunham (Electrical Engineering), Ira Greenberg, Ping Gui (Electrical Engineering), Richard V. Helgason (Engineering Management, Information and Systems), LiGuo Huang. Assistant Professors: Jennifer A. Dworak, Eric C. Larson, Tyler W. Moore. Senior Lecturer: Frank P. Coyle. Lecturers: Donald E. Evans, Mark E. Fontenot. Visiting Fellow: Daniel W. Engels. Adjunct Faculty: Jeffrey D. Alcantara, William A. Bralick, Jr., Ann E. Broihier, Hakki C. Cankaya, Christian P. Christensen, Aaron L. Estes, Dennis J. Frailey, Kenneth R. Howard, Bhanu Kapoor, Mohamed M.I. Khalil, Kamran Z. Khan, R. Mallik Kotamarti, Lun Li, D. Kall Loper, Matthew R. McBride, Lee D. McFearin, Freeman L. Moore, Padmaraj M.V. Nair, Robert S. Oshana, John J. Pfister, Leonid Popokh, Sohail Rafiqi, Mohamed O. Rayes, Gheorghe Spiride, Raymond E. Van Dyke. Emeritus Professor: Margaret H. Dunham.

The Department of Computer Science and Engineering at SMU offers academic programs in computer engineering and computer science. Faculty specializations include computer architecture, data mining, knowledge engineering, software engineering, design and analysis of algorithms, parallel processing, database management, very ye.4907 Tnt, 9gr1rter arch-sre2howr1(d)-4.4(.e)-2.l(R.)84.9(re)]T1

For graduates with degrees in computer engineering

a) The ability to apply knowledge of mathematics, science and engineering to software and hardware design problems.

b) The ability to design and conduct experiments and to analyze and interpret data related to software and hardware design solutions.

c) The ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

d) The ability to function on multidisciplinary teams using current computer engineering tools and technologies.

e) The ability to identify, formulate and solve engineering problems based on a fundamental understanding of concepts of computer engineering topics.

f) An understanding of personal, professional and ethical responsibility.

g) The ability to communicate effectively both in an oral and written form.

h) The broad liberal arts education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.

i) The recognition of the need for and the ability to engage in lifelong learning.

j) A knowledge of contemporary issues in computer engineering.

k) The ability to use the techniques, skills and modern engineering tools necessary for computer engineering practice.

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

Degrees

The CSE Department offers undergraduate degrees as follows:

Bachelor of Science – major in computer science
Bachelor of Science – major in computer science with a premedical specialization
Bachelor of Science in Computer Engineering
Bachelor of Arts – major in computer science

The undergraduate program in computer engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org . The undergraduate computer science program that awards the degree Bachelor of Science (B.S.) is accredited by the Computing Accreditation Commission of ABET. The undergraduate computer science program that awards the degree Bachelor of Arts (B.A.) is not accredited by a Commission of ABET.

Dual Degree Program

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

Requirements for the Major (continued)	*Credit Hours*
Computer Science	44

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oriented concepts of composition, inheritance, polymorphism, and containers. First course for computer science and computer engineering majors and minors.

CSE 1342 (3). PROGRAMMING CONCEPTS. Introduces the constructs provided in the C/C++ programming language for procedural and object-oriented programming. Computation, input and output, flow of control, functions, arrays and pointers, linked structures, use of dynamic storage, and implementation of abstract data types. *Prerequisite:* C- or better in CSE 1341 or equivalent, grade of at least a 4 on the AP Computer Science A Exam, or departmental consent.

CSE 2240 (2). ASSEMBLY LANGUAGE PROGRAMMING AND MACHINE ORGANIZATION. Computer-related number systems, machine arithmetic, computer instruction set, low-level programming, addressing modes and internal data representation. *Pre or Corequisite:* A grade of C- or better in 1341.

CSE 2337 (3). INTRODUCTION TO DATA MANAGEMENT. This course is designed to provide practical experience using a relational database system and spreadsheet system. The course emphasizes hands-on practical training in creation and access of relational databases as well as basic and intermediate data analysis using spreadsheet software. Integrating data from a spreadsheet and relational database into other document types is also covered. No credit for CS and CpE majors or minors.

CSE 2341 (3). DATA STRUCTURES. Emphasizes the object-oriented implementation of data structures and associated algorithms, including sorting algorithms, linked lists, stacks, queues, binary trees, and priority queues. Introduces graphs and algorithm analysis, and covers object-oriented software engineering strategies and approaches to programming. *Prerequisite:* C- or better in CSE 1342 or equivalent.

CSE 2353 (3). DISCRETE COMPUTATIONAL STRUCTURES. Logic, proofs, partially ordered sets, and algebraic structures. Introduction to graph theory and combinatorics. Applications of these structures to various areas of computer science *Prerequisite:* C- or better in CSE 1341.

CSE 3330 (3). DATABASE CONCEPTS. Covers fundamental information management and database systems concepts, including information models and systems, data modeling, relational database design, query languages, and various language APIs for accessing database systems. Contains a major design and implementation project. May include topics from information privacy and security, information retrieval, data mining, and multimedia information systems. *Prerequisites:* C- or better in CSE 2341, 2353.

CSE 3342 (3). PROGRAMMING LANGUAGES. Introduction to basic concepts of programming languages and compilers, including formal syntax, regular languages and finite automata, lexical analysis, context-free grammar and parsing, static and dynamic scoping, equivalence and consistency of data types, control constructs, encapsulation and abstract data types, storage allocation, and run-time environment. Advanced programming techniques such as tail recursion, inheritance, polymorphism, static and dynamic binding, and exception handling. In-depth studies of representative languages of different programming paradigms – object-oriented, logic and functional programming. *Prerequisite:* A grade of C- or better in CSE 2341.

CSE 3345 (3). GRAPHICAL USER INTERFACE DESIGN AND IMPLEMENTATION. Introduction to the concepts underlying the design and implementation of graphical user interfaces with emphasis on the psychological aspects of human-computer interaction. The course is structured around lectures, case studies and student projects. This course will introduce event-driven programming concepts including the Java API, applications, applets, interfaces, graphics, basic and advanced GUI components, HTML and multithreading. *Prerequisites:* A grade of C- or better in CSE 2341 or equivalent.

CSE 3353 (3). FUNDAMENTALS OF ALGORITHMS. Introduction to algorithm analysis, big-Oh notation, and algorithm classification by efficiency. Basic algorithm design strategies and approaches to problem-solving. Sorting and searching algorithms. Introduction to graph theory and graph algorithms. *Prerequisites:* C- or better in CSE 2341, 2353.

CSE 3365/MATH 3315 (3). INTRODUCTION TO SCIENTIFIC COMPUC3.7(5 (3I4(val,)4.9(P)3lPrereg6 -1.136T)-7.4(e9,.5(

CSE 3381 (3). DIGITAL LOGIC DESIGN. Boolean functions, logic gates, memory elements, synchronous and asynchronous circuits, shift registers and computers, and logic and control. *Prerequisites:* C- or better in CSE 2240, 2353.*Corequisite:* Weekly no-credit lab.

CSE 4386 (3). HARDWARE DESIGN PROJECT. This is a project course, which has a major design component. Students participate in a multi-disciplinary group project team. There will be topical discussions in relationship with the project, which include the hardware design and manufacturing process, hardware description languages, modular design principles, quantitative analysis, industrial standards and interfaces, and the importance of lifelong learning. The group project will provide the major design experience for students in the Hardware track of the Computer Engineering program. *Prerequisite:* A grade of C- or better in CSE 4381.

CSE 4391 (3), 4392 (3), 4393 (3), 4394 (3), 4490 (4), 4491 (4), 4492 (4), 4493 (4), 4494 (4). UNDERGRADUATE PROJECT. An opportunity for the advanced undergraduate student to undertake independent investigation, design or development. Written permission of the supervising faculty member is required before registration.

CSE 4397 (3). RESEARCH EXPERIENCE FOR UNDERGRADUATES. Provides research experience for junior/senior undergraduate students. Permission from the advising CSE faculty member is required before registration. *Prerequisites:* Junior/senior standing; computer science or computer engineering major with GPA above 3.000.

CSE 5050 (0). UNDERGRADUATE INTERNSHIP.

CSE 5111 (1). INTELLECTUAL PROPERTY AND INFORMATION TECHNOLOGY. Presents fundamentals in the nature, protection, and fair use of intellectual property. Patent, copyright, trademark, trade secret, and antitrust principles are presented with an emphasis on Internet, software, databases, and digital transmission technologies. Investigates the open source and creative commons alternatives for disseminating intellectual property. Examines the engineer's, scientist's, manager's, and creative artist's professional and ethical responsibilities and opportunities regarding intellectual property. Also, investigates the rapid change in types and uses of

CSE 5330 (3). FILE ORGANIZATION AND DATABASE MANAGEMENT. A survey of current database approaches and systems, principles of design and use of these systems. Query language design, implementation constraints. Applications of large databases. Includes a survey of file structures and access techniques. Use of a relational DBMS to implement a database design project. *Prerequisite:* A grade of C- or better in CSE 3330.

CSE 5331 (3). AN INTRODUCTION TO DATA MINING AND RELATED TOPICS. Introduces various data mining and related concepts. All material covered is reinforced through hands-on implementation exercises. In this introductory course, a high-level applied study of data mining techniques is used. *Prerequisite:* C- or better in CSE 3330.

operating systems, network operating systemsand the Internet, virtual memory management, interprocess communication and synchronization, file organization, and case studies. *Prerequisites:* C- or better in CSE 2240, 3353.

CSE 5344 (3). COMPUTER NETWORKS AND DISTRIBUTED SYSTEMS II. Introduces network protocols, layered communication architec ture, multimedia applications and protocols, quality of service, congestion control, opti cal networks, DWDM, network survivability and provisioning, wireless networks. There will be an interdisciplinary project requiring the use of currently available network design and simulation tools. *Prerequisite:* C- or better in CSE 4344.

CSE 5345 (3). ADVANCED APPLICATION PROGRAMMING. Advanced programming techniques that span a rangeof programming languages and technologies. Includes server-side application development, client GUI implementati on, application frameworks, design patterns, model-based development, and multithreading. The specific programming language or languages covered may vary from term to term.*Prerequisite:* CSE 3345 or consent of instructor.

CSE 5347 (3). XML AND THE ENTERPRISE.

CSE 5360 (3). INTRODUCTION TO 3-D ANIMATION. Introduces computer graphics, with an emphasis on the popular software package Maya. Includes focus on the user interface, creation of 3-D geometry using polygonal techniques, materials and textures, kinematics, animation, and camera and lighting techniques. Explores the various aspects and fundamentals

Electrical Engineering

Professor Dinesh Rajan, Chair

Professors: Jerome K. Butler, Marc P. Christensen, Scott C. Douglas, Delores M. Etter, Gary A. Evans, W. Milton Gosney, Alireza Khotanzad, Sukumaran V.S. Nair (Computer Science and

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

displaying visual stimuli, and a Cambridge Research Systems visual stimulus generator capable of generating a variety of stimuli for use in psychophysical and electrophysiological experiments. Ultrasound data can also measure with a Physical Acoustics apparatus consisting of a watertank, radio frequency pulser/receiver and radio frequency data acquisition system. Several PCs are also available for instrumentation control and data acquisition.

Multimedia Systems Laboratory. This facility includes an acoustic chamber with adjoining recording studio to allow high-quality sound recordings to be made. The chamber is sound-isolating with double- or tr iple-wall sheet rock on all four sides, as well as an isolating ceiling barrier above the drop ceiling. The walls of the chamber have been constructed to be nonparallel to avoid flutter echo and dominant frequency modes. Acoustic paneling on the walls of the chamber are removable and allow the acoustic reverberation time to be adjusted to simulate different room acoustics. The control room next to the acoustic chamber includes a large, 4-foot-by-8-foot acoustic window and an inert acoustic door facing the acoustic chamber. Up to 16 channels of audio can be carried in or out of the chamber to the control room. Experiments to be conducted in the Multimedia Systems Laboratory include blind

ment includes a floating air table, an ar

Engineering Leadership Specialization (continued):

One of EE 5310, 5312, 5314, 5321, 5330, 5332, 5333
One of EE 5360, 5362, 5370, 5371, 5372, 5373, 5374, 5375, 5376, 5377, 5378

Computer Engineering Specialization:

CSE 1341, 1342, 2341, 2353, 3353
EE 5381, 5385

Requirements for the Major (continued)	*Credit Hours*
Advanced Electives	15
One of EE 5360, 5362, 5370, 5371, 5372, 5373, 5374, 5375, 5376, 5377, 5378	
One of EE 5356, 5357, 5381, 5385, 5387	
One of EE 5310, 5312, 5314, 5321, 5330, 5332, 5333	
6 hours from any EE or CSE 5000-level course approved by adviser	
Senior Design Sequence	6
EE 4311, 4312	
	105

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

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

Curriculum Notes. In .0006 612.03 396 -612 re W n .934 .926 4.6(ic 396 -612 re W 3

Bachelor of Science in Electrical Engineering (Biomedical Specialization)

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

Curriculum Notes. In addition to the University-wide requirements, which include the completion of a minimum of 120 academic credit hours for any degree, the term credit hours within this curriculum are distributed as follows:

Requirements for the Specialization	*Credit Hours*
Mathematics and Science	53
MATH 1337, 1338, 2339, 2343 3-hour elective MATH course at the 3000 level or above BIOL 1401, 1402, 3304, 3350 CHEM 1303/1113, 1304/1114, 3371/3117, 3372/3118 PHYS 1303/1105, 1304/1106	
Economics	3
ECO 1311	
Computer Science	3
CSE 1341 *or* 1342	
Core Electrical Engineering	31
EE 1322, 1382, 2322/2122, 2350, 2370/2170, 2381/2181, 3360, 3372, 3381/3181	
Junior Electrical Engineering	6–7
Two from EE 3311, 3322/3122, 3330	
Advanced Electrical Engineering Elective	3
Any EE 5000-level course approved by adviser.	
Biomedical Engineering	6
EE 5340, 5345	
Senior Design Sequence	6
EE 4311, 4312	
	111–112

Minor in Electrical Engineering

For information on a minor in electrical engineering, the student should consult the department. A total of 18 term credit hours in electrical engineering courses are required: EE 2322, 3322, 2350, 2370 and six credit hours of elective electrical engineering courses at the 3000 level or above.

Electrical Engineering Courses (EETS)

The third digit in a course number designator represents the subject area of the course. The following designators are used:

EE 1301 (3). 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 TV. The course is designed for nontechnical students who want to be more knowledgeable. (Not open to EE majors.)

EE 1322 (3). SURVEY OF ELECTRICAL AND ELECTRONIC DEVICES. Introduces beginning electrical engineering to contemporary electrical and electronic devices, including transformers, alternators, generators, motors, relays, loudspeakers, vacuum tubes, transistors, light-emitting diodes, photodetectors, and integrated circuits. Also, how these devices are used in contemporary products. Students research a device type, build a circuit application, and reverse engineer a product. *Prerequisites:*

each student designs, constructs, and tests a solution and then submits a formal report to the faculty in charge of the project. *Prerequisites:* EE 2322, 3381 and EE senior standing.

EE 4312 (3). SENIOR DESIGN II. Areas covered are tailored to the student's area of specialization. The design project selected may be a continuation of the project undertaken in EE 4311, a new project selected from the list of available projects offered by the faculty, or a project proposed by the student and approved by the faculty. Depending upon the specifics of the project, a team designs, constructs, and tests a solution and then submits a formal report to the faculty in charge of the project. *Prerequisite:* EE 4311.

EE 5050 (0). UNDERGRADUATE INDUSTRIAL INTERNSHIP. This course represents a term of industrial work experience for non-cooperative education students. The course designates a student as full time for the term, but carries no academic credit. Students register for the course

microsensors, and micromotors; principles of operation; micromachining techniques (surface and bulk micromachining); IC-derived microfabrica tion techniques; and thin lm technologies as they apply to MEMS. *Prerequisite:* EE 3311.

EE 5370 (3). COMMUNICATION AND INFORMATION SYSTEMS. An introduction to communication in modulation systems in discrete and continuous time, information content of signals, and the transition of signals in the presence of noise. Amplitude, frequency, phase and pulse modulation. Time and frequency division multiplexing. *Prerequisite:* EE 3360.

EE 5371 (3). 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.

EE 5372 (3). TOPICS IN DIGITAL SIGNAL PROCESSING. This course is intended to provide an extended coverage of processing of discrete-time signals. Discrete-time signals and the analysis of systems in both the time and frequency domains are reviewed. Other topics covered will include multi-rate signal processing, digital filter structures, filter design and power spectral estimation. *Prerequisite:* EE 3372.

EE 5373 (3). 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 TMS320C50, a fixed-point processor. The emphasis is on assembly language programming, and the laboratories utilize a hands-on approach that will focus on the essentials of DSP programming while minimizing signal processing theory. Laboratory topics include implementation of FIR and IIR filters, the FFT, and a real-time spectrum analyzer. *Suggested:* Some basic knowledge of discrete-time signals and digital logic systems. *Prerequisite:* EE 3372.

EE 5374 (3). DIGITAL IMAGE PROCESSING. Provides an introduction to the basic concepts and techniques of digital image processing. Topics covered will include characterization and representation of images, image enhancement, image restoration, image analysis, image coding, and reconstruction. *Prerequisite:* EE 5372.

EE 5375 (3). RANDOM PROCESSES IN ENGINEERING. An introduction to probability and stochastic processes as used in communication and control. Topics include probability theory, random variables, expected values and moments, multivariate Gaussian distributions, stochastic processes, autocorrelation and power spectral densities, and an introduction to estimation and queuing theory. *Prerequisite:* EE 3360.

EE 5376/CSE 5376 (3). INTRODUCTION TO COMPUTER NETWORKS. This is an introductory course that surveys basic topics in communication networks with an emphasis on layered protocols and their design. Topics include OSI protocol reference model, data link protocols, local area networks, routing, congestion control, network management, security, and transport layer protocols. Network technologies include telephony, cellular, Ethernet, Internet protocol (IP), TCP, and ATM. Assignments may include lab exercises involving computer simulations. *Corequisite:* EE 5176 and senior standing.

EE 5377 (3). EMBEDDED WIRELESS DESIGN LABORATORY. A wide variety of real-world experiences in wireless communications and networking using FPGAs equipped with embedded microprocessors. Covers basic wireless concepts of scheduled and random access as well as modulation and power control via labs that enable implementation of cellular and 802.11-based wireless protocols such as TDMA, Aloha, CSMA, and CSMA/CA. Also, broader topics that range from embedded programming, interrupt-driven operation, and FPGA-based design are covered in some depth. In a course project, student teams design novel wireless protocols and carry out experiments to measure the performance. *Prerequisite:* C- or better in EE 3360 or equivalent, or permission of instructor.

EE 5378 (3). MOBILE PHONE EMBEDDED DESIGN. In this course, students learn how to develop embedded software for the most widely used smartphone platforms with an emphasis on wireless and sensing applications. Topics include user interface design such as multi-touch and basic HCI design tenets, storing and fetching data with local networked systems and databases, localization via GPS and wireless signal triangulation, sensing environmental and user characteristics, networking with various wireless protocols, graphics rendering, multimedia streaming, and designing for performance such as controlling memory leaks, object allocation, and multi-threading. Content from the course draws from various fields including wireless communications and networking, embedded programming, and computer architecture.

and workstations are the primary desktop equipment. All computing facilities are networked via high-speed Ethernet, with Gigabit Ethernet connections to Internet 1, Internet 2 and the National Lambda Rail research network. Open computing labs and wireless services provide additional facilities access points for students.

Curriculum in Management Science

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

EMIS 1360 (3). INTRODUCTION TO MANAGEMENT SCIENCE. Management science is the application of mathematical modeling and scientific principles to solve problems and improve life in society. Students learn to develop plans, manage operations, and solve problems encountered in business and government. *Prerequisite:* Knowledge of college-level algebra. *Corequisites:* MATH 1337, CSE 1341.

EMIS 2360 (3). ENGINEERING ECONOMY. Evaluation of engineering alternatives by equivalent uniform annual cost, present worth, and rate-of-return analysis. Use of a computerized financial planning system. 0.5 TCH design. Credit not allowed for both EMIS 2360 and EMIS 8361. *Prerequisites:* C- or better in MATH 1337 and knowledge of introductory probability and statistics. *Corequisites:* MATH 1338 and CSE 1342 (must enroll in lab).

EMIS 3150 (1). 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.

EMIS 3308 (3). ENGINEERING MANAGEMENT. Examines planning, financial analysis, organizational structures, management of the corporation (including its products, services, and people), transfer of ideas to the marketplace, and leadership skills. Credit is not allowed for both EMIS 3308 and the same course offered by another department; credit is not allowed for both EMIS 3308 and EMIS 7351. *Prerequisite:* Junior standing. Lyle undergraduate majors only.

EMIS 3309 (3). INFORMATION ENGINEERING AND GLOBAL PERSPECTIVES. Examines global and information aspects of technology- and information-based companies. Credit is not allowed for the same course offered by another department. *Prerequisite:* Junior standing. Lyle undergraduate majors only.

EMIS 3340/CSE 4340/STAT 4340 (3). STATISTICAL METHODS FOR ENGINEERING 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. Credit is not allowed for both EMIS 3340/ST AT/CSE 4340 and EMIS 5370. *Prerequisite:* C- or better in MATH 1338.

EMIS 3360 (3). OPERATIONS RESEARCH.

EMIS 5300 (3). SYSTEMS ANALYSIS METHODS. Introduction to mode ling 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.

EMIS 5332 (3). DATA MINING FOR ANALYTICS. Analytics is based on collecting, managing, exploring, and acting on large amounts of data, and it has become a source of competitive advantage for many organizations. This course introduces data-mining techniques (classification, association analysis, and cluster analysis) used in analytics. All material covered is reinforced through hands-on experience using state-of-the art tools to design and execute data-mining processes. *Prerequisite:* Background in descriptive statistics and probability.

EMIS 5361 (3). COMPUTER SIMULATION TECHNIQUES. Introduces the design and analysis of discrete probabilistic systems using simulation. Emphasizes model construction and a simulation language. *Prerequisites:* Programming ability, introduction to probability or statistics.

EMIS 5362 (3). PRODUCTION SYSTEMS ENGINEERING. Applies the principles of engineering, or "design under constraint," to modern production systems. Topics include production systems analysis and design considerations, system design and optimization models and methods, pull- and push-based production systems, quality engineering, and process improvement. Also, techniques for engineering and managing systems with specific architectures: batch-oriented, continuous-flow, projects, and just-in-time. *Prerequisite:* C- or better in EMIS 3360. Management science or math operations research specialization majors only.

EMIS 5364/STAT 5344 (3). STATISTICAL QUALITY CONTROL. A comprehensive introduction to the statistical quality-control methods that underlie the modern quality revolution. Statistics and simple probability are used to develop control charts to monitor and improve the quality of an ongoing process, and for acceptance-sampling plans (including MIL-STD). Control charts for attributes, variables, and Cusum procedures are defined and applied to everyday problems in manufacturing and service businesses. 0.5 TCH Design*Prerequisite:* EMIS 3340 (STAT/CSE 4340), EMIS 5370, or STAT 5373.

EMIS 5365 (3). PROGRAM AND PROJECT MANAGEMENT. Development of principles and practical strategies for managing projects and programs of related projects for achieving broad goals. Topics include planning, organizing, scheduling, resource allocation, strategies, risk management, quality, communications, tools, and leadership for projects and programs.

EMIS 5366 (3). MARKETING ENGINEERING. Marketing engineering moves beyond traditional conceptual approaches to embrace the use of analytics, data, information technology, and decision models to help organizations effectively reach customers and make marketing decisions. Designed for technical individuals, the course applies engineering problem-solving approaches and computer tools to solve marketing problems from today's competitive work environment. *Prerequisites:* EMIS 3340 (STAT/CSE 4340) or EMIS 5370, and EMIS 3360 (or equivalent).

EMIS 5369 (3). RELIABILITY ENGINEERING. Introduction to reliability engineering concepts, principles, techniques, and methods required for design and development of affordable products and services that meet customer expectations. 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. *Prerequisite:* C- or better in EMIS 4340 or 5370.

EMIS 5377/STAT 5377 (3). STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS. Introduction to statistical principles in the design and analysis of industrial experiments. Completely randomized, randomized complete and incomplete block, Latin square, and Plackett-Burman screening designs. Complete and fractional factorial experiments. Descriptive and inferential statistics. Analysis of variance models. Mean comparisons. *Prerequisites/corequisites:* C- or better in EMIS 3340 and senior standing with a Science or Engineering major, or permission of instructor.

EMIS 5380 (3). MANAGING INFORMATION TECHNOLOGY CONTROLS. This course surveys current practices in information technology (IT) governance and controls, with approaches for balancing business needs with technology controls for high-risk processes. Major topic areas include introduction to technology controls, the process of IT governance, systems and infrastructure life cycle management, IT delivery and support, and records management.

EMIS 5382 (3). INFORMATION TECHNOLOGY SECURITY AND RISK MANAGEMENT. This course is for non-technical managers and executives with decision-making responsibility in information security governance and risk management. Topics include information security organizations and policies, governance, program develop0 Tc -.iza949 6(t).ance hformar k manTD -.041lv(n)

Mechanical Engineering

Professor Ali Beskok, Chair

Professor Radovan Kovacevic, Director, Research Center for Advanced Manufacturing

Professors: Yildirim Hürmüzlü, Radovan B. Kovacevic, Paul S. Krueger, José L. Lage, M. Volkan Otugen, Bijan Mohraz (Civil and Environmental Engineering), Peter E. Raad, Wei Tong. Associate Professors: Charles M. Lovas, Edmond Richer, David A. Willis. Assistant Professors: Tindaro Ioppolo, Jeong Ho You. Senior Lecturers: Elena V. Borzova, Dona T. Mularkey. Clinical Research Assistant Professor: Adam L. Cohen. Adjunct Faculty: Bogdan V. Antohe, Eric B. Cluff, Santos Garza, M. Wade Meaders, David J. Nowacki, Mauricio A. Salinas, Allen D. Tilley, Andrew K. Weaver, James M. Webb. Emeritus Professors: David B. Johnson, Paul F. Packman, Cecil H. Smith, Hal Watson, Jr.

Mechanical engineering is a diverse, dynamic and exciting field. Mechanical engineers have wide-ranging technical backgrounds and a high potential for employment that offers the mobility necessary for professional growth. They apply creative knowledge to solve critical problems in several different areas, such as bioengineering (e.g., drug-delivery; artificial organs), construction, design and manufacturing, electronics, energy (e.g., production, distribution and conservation), maintenance (individual machinery and complex installations), materials processing, medicine (diagnosis and therapy), national security and defense, packaging, pollution mitigation and control, robotics and automation, sensors, small-scale devices, and all aspects of transportation, including space travel and exploration.

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

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

The curriculum consists of three major areas, namely, structures, thermal and fluids, and systems and dynamics and control, interlaced via practical mechanical engineering design throughout the curriculu m. In the senior year, student teams are guided through a complete design project, from concept to construction to testing, with support from industries , foundations and volunteer professionals. State-of-the-art software, computers and laboratory equipment support the high-quality education provided to students. Moreover, undergraduate students are encouraged to

participate in research projects conducted by faculty and to consider extending their studies toward a graduate degree in mechanical engineering at SMU or elsewhere.

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

The undergraduate program in mechanical engineering is accredited by the

tion for sensor development in the micro-size level with a nano-level measurement sensitivity.

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

Research Center for Advanced Manufacturing. The RCAM center supports research and development activities in areas of rapid prototyping and manufacturing (laser-based and welding-based deposition), laser materials processing (welding, forming, surface modification), welding (including electrical arc welding, variable polarity plasma arc welding, friction stir welding, and micro plasma arc welding), waterjet/abrasive waterjet materials processing, sensing and control of manufacturing processes, and numerical modeling of manufacturing processes.

Center for Laser-Aided Manufacturing. This facility, which is housed in the Research Center for Advanced Manufacturing facility, collaborates with RCAM.

Energy Harvesting Materials Laboratory. Due to the limited reserves of fossil fuels like coals, oil and natural gas, finding an efficient way to produce renewable energy from natural resources is in great demand. In the Energy Harvesting Materials Laboratory, research focuses on the investigation and design of materials to generate electricity from solar light (solar cells), from mechanical vibration (piezoelectric power generators) and from temperature difference (thermoelectric systems). Research focuses on small-scale materials (nanomaterials) to improve energy conversion efficiency in those systems based on atomic-scale and continuum approaches.

Biomedical Instrumentation and Robotics Laboratory. This laboratory's research activities promote strong interdisciplinary collaboration between several branches of engineering and biomedical sciences. The research interests are centered on two areas:

- Medical robotics, especially novel robotic applications in minimally invasive, natural orifice, and image-guided and haptic-assisted surgery.
- In vivo measurement of mechanical properties of biological tissue.

School of Engineering computational facilities include several high-speed, multiprocessor workstations and servers. Educational software includes Parametric Technologies Pro-Engineer CAD system, MATLAB, ANSYS structural analysis package, MacroFlow and Fluent CFD packages.

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

Mechanics of Materials (Structures) Laboratory. This laboratory is equipped for

vides 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

In addition to the required 87 credit hours in core mathematics, science and engineering courses, students must satisfy the minor in business administration requirements (listed in the Cox School of Business section of this catalog); three hours of ME courses at the 3000 level or higher approved by the student's adviser are also required. Admission requirements to the Cox School must also be satisfied and may include additional coursework.

Bachelor of Science in Mechanical Engineering

Curriculum Notes. In addition to the University-wide requirements, which include the completion of a minimum of 120 academic credit hours for any degree, the term credit hours within the mechanical engineering curriculum are distributed as follows:

Requirements for the Major	*Credit Hours*
Mathematics and Science	31
MATH 1337, 1338, 2339, 2343, 3353	
STAT 4340 *or* equivalent	
CHEM 1303	
PHYS 1303/1105, 1304	
One from the following:	
BIOL 1401, 1402	
CHEM 1304	
GEOL 1301, 1305, 1307, 1308, 1313	
PHYS 3305, 3340, 4321	
3000-level *or*	

Any deviation from the mechanical engineering and/or physics curricula requires

energy methods, and column buckling. *Prerequisite:* ME/CEE 2310. *Corequisite:* ME/CEE 2140.

ME 2342/CEE 2342 (3). FLUID MECHANICS. Fluid statics, fluid control volume, and applications; irrotational flow; Bernoulli's and Euler's equations; similitude and dimensional analysis; differential analysis of fluid flow; incompressible viscous flow; and boundary layer theory. *Prerequisites:* ME/CEE 2310, MATH 2339, PHYS 1303. *Corequisite:* MATH 2343. ME/CEE 2320 is recommended but not required.

ME 3132 (1). HEAT TRANSFER LABORATORY. One three-hour laboratory session per week. Experiments in conduction, convection, and radi ation to complement lecture material of ME 3332 -- Heat and Mass Transfer. Prerequisite or *Corequisite:* ME 3332.

ME 4360 (3). 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, Bodediagrams, performance criteria, and system compensation. Design of control systemsfor mechanical systems. 1 TCH Design*Prerequisite:* ME 5322 or equivalent.

ME 4370 (3). ELEMENTS OF MECHANICAL DESIGN.

ME 5320 (3). INTERMEDIATE DYNAMICS. Emphasizes methods of formulation and solution of the kinematical, dynamical, and motion constraint equations for three-dimensional, lumped-parameter, dynamical systems. Detailed discussions on differentiation of vectors, kinematics, inertia properties, momentum and energy principles, generalized forces, holonomic and non-holonomic constraints, constrained generalized coordinates, and Newton-Euler and Lagrange formulations of the equations of motion. The symbolic software Mathematica is used to reduce the time and effort required to derive the kinematical and dynamical equations. Practical examples of detailed motion analysis of mechanisms using CAD software augment the theoretical formulations. *Prerequisite:* ME/CEE 2320; MATH 2339, 2343.

ME 5344 (3). CONDUCTIVE COOLING OF ELECTRONICS. This course will begin with a review of the fundamental concepts of conduction heat transfer, followed by applications of these principals to the conductive cooling of electronic components and systems. The following special topics will be emphasized: contact conductance, interface thermal resistance, heat spreaders, thermal interface materials (TIMs), phase change materials (PCMs), thermoelectric devices, Stirling cycle refrigerators, and the cooling of special electronic components, such as multi-chip modules, power modules, high density power supplies, and printed wiring boards. The thermal management by conduction of GaAs and GaN MMICs (monolithic microwave integrated circuits) will be featured. Both steady state and transient analyses will be employed, including a discussion of transient junction-to-case thermal resistance measurements. *Prerequisite:* ME 3332.

ME 5346 (3). APPLICATION OF COMPUTATIONAL TECHNIQUES TO THE MECHANICAL AND THERMAL DESIGN OF ELECTRONIC SYSTEMS. This course will develop the student's capability to characterize the mechanical and thermal performance of electronic devices and systems through the use of computational techniques. Commercial codes will be used to create a thermal model of a fan-cooled, rectangular geometry, electronics chassis, using direct air-cooling. Additional computer codes for thermal modeling of heat transfer and fluid flow systems will be featured. In addition, codes for the design of cold plates and heat exchangers will be utilized. The student will be exposed to concepts of structural modeling of components mounted on printed wiring boards in a vibration environment. A number of industry-related problems, ranging from first-level packages, printed wiring boards, and system-level electronics will be analyzed. At the end of the class, a student will be expected to formulate and model a complex industry-based problem. *Prerequisite:* ME/CEE 2320, 2340, ME 3332, 3340.

ME 5359 (3). 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; semi-conductor 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.

ME 5360 (3). ELECTRONIC PRODUCT DESIGN AND RELIABILITY. This course will investigate the failures, failure modes, and failure mechanisms in electronic systems. It will cover the following subjects: failure detection, electrical simulation, and environmental stress tests. Failure analysis will be covered, including the use of X-rays, thermal imaging/infrared microscopy, acoustical imaging, scanning laser acoustic microscopy, infrared spectroscopy, differential scanning calorimeter, thermo-mechanical analyzer, and other testing procedures. In addition, solder joint reliability of balls grid array (BGA) assemblies, plastic ball grid array (PBGA) assemblies, flip-chip assemblies, chip-scale package (CSP) assemblies, and fine pitch, surface mount technology (SMT) assemblies will bediscussed. In addition, this course will cover temperature as a reliability factor, an overview of high temperature electronics, the use of silicon devices at high temperatures, and select

in CAM Flexible manufacturing cells and systems. Hands-on laboratory work with industrial robots and NC machines. Independent study and report on a specific robot application. 2 TCH Design. *Prerequisites:* CSE 1341, PHYS 1303, 1105 and MATH 2343 or equivalent.

ME 5377/CEE 5377 (3). ADVANCED STEEL DESIGN. Behavior and design of steel structures including general methods of plastic analysis, plastic moment distribution, steel frames, unbraced and braced frames,and composite construction. *Prerequisite:* ME 4350.

ME 5383 (3). HEATING, VENTILATING, AND AIR CONDITIONING. Selection and design of basic refrigeration, air conditioning, and heat ing systems are treated. Load calculations, psychometrics, cooling coils, cooling towers, cryogenics, solar energy applications, and special topics are included. 1 TCH Design.*Prerequisites:* ME/CEE 2331 and ME 3332.

ME 5386 (3). CONVECTION HEAT TRANSFER. Advanced topics in forced convection heat transfer using analytical methods and boundary-layer analysis. Laminar and turbulent flow inside smooth tubes and over external surfaces Convection processes in high-speed flows. *Prerequisite:* ME 3332 or equivalent.

ME 5390 (3), 5490 (4). 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 chair of the department in which the student expects to receive the degree. Variable credit of one to four term hours. Variable TCH Design.

ME 5391 (3), 5392 (3), 5393 (3), 5394 (3), 5395 (3), 5491 (4). 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.

The Courses (ENGR)

ENGR 1101 (1). ENGINEERING AND BEYOND. Explores the five engineering departments at SMU and how the areas work together. Includes case studies, departmental presentations, industry panels, and industry tours.

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

The Courses (SS)

SS 1099 (0), 2099 (0), 3099 (0), 4099 (0), 5099 (0). ENGINEERING INTERNSHIP. Each of these courses represents a term of industrial work activity in connection with the Engineering Cooperative Program. The courses are taken in numerical sequence and carry no credit. Students register for these courses in the same manner as other SMU courses except that no tuition is charged. Each course grade is determined by a written report by the student and from the scoring of the employer's evaluation form.

SS 2315 (3). ENGINEERING AND DESIGN FOR THE DEVELOPING WORLD. Engineering design in the developed world takes for granted the availability of several key resources such as construction material, water, and electricity. This course examines engineering design in the absence of these resources, with a focus on the development of shelter and sanitation in an efficient manner. Emphasis on understanding the total energy cycle of a structure and multiple alternative energy solutions. Additional topics include developing solutions for extreme low-cost, high-population densities and ecological sustainability. Students work in interdisciplinary teams to design and build energy-efficient homes and sustainable sanitation options and to investigate alternative energy systems. *Prerequisite:* PHYS 1303. *Corequisites:* SS 2320 and sophomore or above standing.

SS 2320 (3). ENVIRONMENTAL FIELD METHODS. Covers topics related to environmentally relevant fieldwork in the developing world, with emphasis on field and lab practical experiences that are supplemented with necessary lecture. Addresses surface water and groundwater collection as well as the analysis of coliform bacteria, basic water quality parameters, and inorganic contaminants. Topics also include soil collection and analysis, sanitation and water systems in the field, mapping, basic GIS, and systems planning. *Corequisites:* SS 2315 and sophomore or above standing.

SS 5090 (0), 5091 (0), 5092 (0), 5093 (0), 5094 (0). SPECIAL TOPICS. Individual or group study of selected topics in applied science. These are areas that do not belong strictly to any department, but nevertheless are meaningful to the Lyle School of Engineering. *Prerequisite:* Permission of instructor.

SS 5190 (1), 5191 (1), 5192 (1), 5193 (1), 5194 (1). SPECIAL TOPICS. Individual or group study of selected topics in applied science. These are areas that do not belong strictly to any department, but nevertheless are meaningful to the Lyle School of Engineering. *Prerequisite:* Permission of instructor.

SS 5290 (2), 5291 (2), 5292 (2), 5293 (2), 5294 (2). SPECIAL TOPICS. Individual or group study of selected topics in applied science. These are areas that do not belong strictly to any department, but nevertheless are meaningful to the Lyle School of Engineering. *Prerequisite:* Permission of instructor.

SS 5390 (3), 5391 (3), 5392 (3), 5393 (3), 5394 (3). SPECIAL TOPICS. Individual or group study of selected topics in applied science. These are areas that do not belong strictly to any department, but nevertheless are meaningful to the Lyle School of Engineering. *Prerequisite:* Permission of instructor.

SS 5490 (4), 5491 (4), 5492 (4), 5493 (4), 5494 (4). SPECIAL TOPICS. Individual or group study of selected topics in applied science. These are areas that do not belong strictly to any department, but nevertheless are meaningful to the Lyle School of Engineering. *Prerequisite:* Permission of instructor.

Army ROTC. While Army ROTC courses are not offered on the SMU campus, students can participate in the Army ROTC program at the University of Texas at Arlington by enrolling as they enroll for other SMU courses. Further program

making safety assessments, movement techniques, planning for team safety/security, and pre-