GENERAL INFORMATION

The Lyle School of Engineering, named in 2008 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 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 Dig-

- Create a science of cyber security and address priorities in the national arena.
- Help close the skills gap in cyber security by tapping into the innovation capabilities of students to meet the demand for trained cyber professionals.

Caruth Institute for Engineering Education. The institute develops programs that increase the number and diversity of students who graduate from U.S. high schools with both the enthusiasm and knowledge to pursue the engineering careers necessary for the U.S. to compete in a global economy.

Hunter and Stephanie Hunt Institute for Engineering and Humanity. More than 1 billion people around the world live on less than $1 per day; of those, 70 percent are women. The institute strives to change the standard of living for the

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- 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:

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

Students who want to participate in the SMU Co-op Program should begin the application process during their first year to allow for career preparation. The application process includes attending Co-op Orientation, receiving interview skills training, résumé review, learning the job search process, and completing the Co-op Program application. The program director guides students through each step of the process.

Each applicant receives quality advising from the program's associate director. A direct result of advising.6(i).7(rents)78(ep v32-60.4o)7(.9(a)-60.8((ep v32-60.4o)-56.9(e (rents)7(ep v

Policies of the Cooperative Engineering Education Program

Since 1925, the school has created and maintained numerous corporate relationships. Many factors contribute to these relationships, including the quality of SMU's academics and research, the achievements of alumni, and SMU's close proximity to high-tech corporations. Each SMU Co-op Program student directly benefits from the program's strong corporate relationships and bears an obligation to preserve these relationships by following the Co-op Program Undergraduate Student Agreement. The agreement balances the student's individual needs with the long-term goal of maintaining the program's corporate relationships for future SMU students. The terms of the program include, but are not limited to, the following:

- Students must maintain good standing with SMU and their employer at all times.
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maximum of 20 hours a week. Students who are actively participating in a full-time

Admission to Advanced Standing

Admission From Dedman College and Other Schools Within SMU

After completion of the engineering subset, students are admitted to the Lyle School of Engineering through an interschool transfer. These transfers are approved by the appropriate department chair and the associate dean of the Lyle School of Engineering. For admission, a student must have completed 24 credit hours and must demonstrate the ability to achieve academic success in engineering or applied science by attaining a 2.000 or higher cumulative GPA. For admission into the civil engineering, computer engineering, computer science, electrical engineering, environmental engineering or mechanical engineering program, a 2.500 or higher GPA – and for management science, a 3.000 or higher GPA – is required in the following courses: DISC 1312/2305, 1313/2306 or equivalent, MATH 1337, 1338 or equivalent and the courses as follows for each Lyle major:

Civil Engineering	CEE 1302, CEE/ME 2310
Computer Engineering	CSE 1341 and 1342, KNW 2300, and *C*- or better in all subset courses
Computer Science	CSE 1341 and 1342, KNW 2300, and *C*- or better in all subset courses
Electrical Engineering	EE 1322, 1382 and 2381; CSE 1341; CHEM 1303; PHYS 1303 (minimum of two)
Environmental Engineering	CEE 1302, CEE/ME 2310
Management Science	EMIS 1360, CSE 1341 and 1342, and *C* or better in all subset courses (Once a student enters SMU, all remaining subset courses must be completed through enrollment at SMU.)
Mechanical Engineering	ME 1302, ME 1305 *or* CSE 1341, ME/CEE 2310 (minimum of two)

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

Admission by Transfer From Another Institution

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

department on the basis of criteria prescribed by the department, but all programs include the following requirements:

- A major GPA of 3.500 or higher.
- Successful completion of three hours of senior thesis approved by the academic adviser.
- Formation of a supervisory committee consisting of three members, with the chair being a resident tenured or tenure-track faculty member of the department, and a minimum of two full-time Lyle faculty members.
- Successful defense of the senior thesis, which consists of the presentation of the senior thesis in a public forum and subsequent oral examination by the supervisory committee to satisfy itself that the student performed the independent reading and conducted the research.

Currently, the Computer Science and Engineering Department and the Electrical Engineering Department offer departmental distinction programs.

Universitywide Requirements

All SMU undergraduate students share a common program of study designed to assure them of a broad liberal education regardless of their major. This requirement is designed to help each student learn to reason and think for oneself, become skilled in communicating and understanding, understand both the social and the natural worlds and one's own place and responsibilities in these environments, and understand and appreciate human culture and history in various forms, including religion, philosophy and the arts. Students should see the Universitywide Requirements section of this catalog for more information.

Dual Degree Programs

The Lyle School of Engineering offers concurrent dual degree programs with other SMU schools. Students may design and pursue a second major or minor degree program in consultation with their academic adviser.

PROGRAMS OF STUDY

Degree Information

The Lyle School of Engineering offers the following degrees:

Bachelor of Science in Civil Engineering

Bachelor of Science in Computer Engineering

Bachelor of Science in Electrical Engineering

Bachelor of Science in Environmental Engineering

Bachelor of Science in Mechanical Engineering

Bachelor of Science (Computer Science)

Bachelor of Science (Management Science)

Bachelor of Arts (Computer Science)

Engineering work can be classified by function, regardless of the branch, 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,

CIVIL AND ENVIRONMENTAL ENGINEERING

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

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

General Information

Undergraduate programs within the Department of Civil and Environmental Engineering educate and train leaders in the fields of environmental protection, resource management, construction and engineering design. Programs are tailored to the individual needs and interests of CEE students, so that students with interests in studying global climate change, protecting the quality of the drinking water, or

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

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

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

The air quality/meteorology and water quality laboratories have sophisticated analytical capabilities for performing chemical analyses of air samples and for assessing the quality of water supplies and wastes and the effectiveness of water and

Bachelor of Science in Civil Engineering

In addition to the Universitywide requirements, which include the completion of a minimum of 120 academic credit hours for any degree, the term credit hours within the civil engineering curriculum are distributed as follows:

Requirements for the Major	*Credit Hours*
Mathematics and Science	34
MATH 1337, 1338, 2339, 2343 STAT 4340 *or* 5340 CHEM 1303/1113, 1304/1114 GEOL 1301 *or* 1315 PHYS 1303/1105, 1304/1106	
Engineering Science and Design	13
CEE 2320, 2331, 2342/2142, 3310	
Civil Engi 5 2331, 2342/2142, 3310	

Bachelor of Science in Environmental Engineering

In addition to the Universitywide requirements, which include the completion of a minimum of 120 academic credit hours for any degree, the term credit hours within the environmental engineering curriculum are distributed as follows:

Requirements for the Degree	*Credit Hours*
Mathematics and Science	38
MATH 1337, 1338, 2339, 2343 STAT 4340 *or* 5340 CEE 1331, 5418 CHEM 1303/1113, 1304/1114 PHYS 1303/1105, 1304/1106	
Engineering Science and Design	12
CEE 2310, 2331, 2342, 3310	
Environmental Engineering and Design	39
CEE 1302, 2304, 2421, 2372, 3323, 3341, 3431, 3451, 4380, 4381, 5317, 5354	
Environmental Technical Electives	6
Selected with adviser's approval.	
Engineering Leadership	9
CEE 3302; two from CSE 4360; EMIS 3308, 3309	
	104

Bachelor of Science in Environmental Engineering and Bachelor of Science With a Major in Mathematics

In addition to the Universitywide 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 Major	*Credit Hours*
Mathematics and Science	50
MATH 1337, 1338, 2339, 2343, 3315 or 3316, 3337 Two advanced MATH electives approved by math adviser STAT 4340 *or* 5340 CEE 1331, 5418 CHEM 1303 1113, 1304/1114 PHYS 1303/1105, 1304/1106	
Engineering Science and Design	12
CEE 2310, 2331, 2342, 3310	
Environmental Engineering and Design	39
CEE 1302, 2304, 2372, 2421, 3323, 3341, 3431, 3451, 4380, 4381, 5317, 5354	
Advanced Environmental / Mathematics Electives	6
Two from CEE 5331, 5332, 5334; ME 5336	
	107

Bachelor of Science in Environmental Engineering With a Premedical Specialization

In addition to the Universitywide 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

An additional six hours of breadth are required, satisfied by taking one course from each of the two remaining concentrations. Students complete the capstone experience requirement by taking CEE 5391. The primary intent of the capstone experience is to incorporate site-based service learning opportunities for students through internships arranged by the Hunter and Stephanie Hunt Institute for Engineering and Humanity at the Lyle School of Engineering. Other opportunities, such as research, may also be accommodated based on individual student interests and career goals.

The Courses (CEE)

CEE 1301 (3). ENVIRONMENT AND TECHNOLOGY: ECOLOGY AND ETHICS. Introduces the economic, engineering, ethical, political, scientific, and social considerations of environmental decision-making and management. Examines local, regional, and global topics. Students take off-campus field trips.

CEE 1302 (3). INTRODUCTION TO CIVIL AND ENVIRONMENTAL ENGINEERING. Introductory course that emphasizes fundamental science, engineering, and ecological principles. Students develop their analytical and critical thinking skills with real-world problem-solving. Many of the hallmarks of modern society (e.g., high-rise office buildings, increased life span, 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, environmental and civil engineers are at work on the many problems currently confronting developing nations: housing supply, food production, air and water pollution, spread of disease, traffic congestion, and flood control.

water pollution, and emphasizes contemporary topics such as hazardous waste, risk assessment, groundwater contamination, global climate change, stratospheric ozone depletion, and acid deposition. Where appropriate, describes pertinent environmental legislation, derives and applies engineering models, and introduces treatment technologies.

application of hydrologic simulation models. Exposes students 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. Introduces concepts of professional engineering practice, with emphasis on the need for professional licensing and project management through all phases of a typical project, including conception, planning, preparation of design drawings and specifications for bidding and procurement purposes, the interaction of design and construction professionals, and water resource systems operation. *Prerequisite:* CEE 2304. *Prerequisite or corequisite:* CEE/ME 2342.

CEE 3325 (3). GROUNDWATER HYDROLOGY. Introduces the hydrologic cycle and the subjects of porosity and permeability. Examines 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. Considers well hydraulics, stream-aquifer interaction, and distributed- and lumped-parameter numerical models, as well as groundwater quality, mixing cell models, contaminant transport processes, dispersion, decay and adsorption, and pollution sources. *Prerequisites:* MATH 2343, CEE/ME 2342.

CEE 3327 (3). PRINCIPLES OF SURFACE WATER HYDROLOGY AND WATER QUALITY MODELING. Examines the theory and applications of the physical processes of the hydrologic cycle. Reviews different types of water bodies (streams, rivers, estuaries, bays, harbors, and lakes). Examines the principal quality problems associated with bacteria, pathogens, viruses, dissolved oxygen and eutrophication, toxic substances, and temperature. Emphasizes theoretical model approaches. *Prerequisites:* CEE 2421, MATH 2343.

CEE 3341 (3). INTRODUCTION TO SOLID AND HAZARDOUS WASTE MANAGEMENT. Examines technology, health, and policy issues associated with solid waste and hazardous materials. Introduces methods of managing solid and hazardous waste and presents regulations where appropriate. Also, the definition and characteristics of hazardous and solid waste materials, health frameworks, and the distribution of contaminants in the environment. *Prerequisites:* CEE 2304, 2421.

CEE 3350/ME 3350 (3). STRUCTURAL ANALYSIS. Emphasis on the classical methods of analysis of statically determinate and indeterminate structural systems. Also, computation of reactions, shears, moments, and deflections of beams, trusses, and frames. Students use computers as an analytical tool. *Prerequisites:* CEE/ME 2340, 2140.

CEE 3353 (3). INTRODUCTION TO ENVIRONMENTAL TOXICOLOGY. The physiological and biochemical effects of physical, chemical, and biological processes are linked to factors present in the environment. Describes natural phenomena in terms of the carbon, oxygen, sulfur, phosphorus, and heavy metal cycles. Examines the processes by which anthropogenic chemicals enter the environment and their complex effects on living organisms. *Prerequisite:* BIOL 1401. *Prerequisite or corequisite:* CHEM 3371.

CEE 3355 (3). ENVIRONMENTAL IMPACT EVALUATION, POLI,ww1 Tce[s applr3TD-.0001P)-6(

spheric ozone depletion. *Prerequisites:* CHEM 1303, MATH 1337 or equivalent, and PHYS 1303 or equivalent.

CEE 3451 (4). INDUSTRIAL HYGIENE AND OCCUPATIONAL HEALTH. Presents the recog-

current interest in environmental and civil engineering. All students, staff, and faculty are invited.

CEE 5191 (1). 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 5192 (1). 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 5291 (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 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 the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act. Also, regulations and the regulatory framework, definitions and substantive requirements, roles of the states and the federal Environmental Protection Agency, compliance and enforcement, and case studies.

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

CEE 5313/CEE 7313 (3). ENVIRONMENTAL CHEMISTRY AND BIOLOGY. Covers chemical and biochemical processes, chemical thermodynamics, acid-base equilibria, precipitation and dissolution, oxidation-reduction processes, environmental transformations of organic materials, introductory taxonomy, microbial growth and kinetics, energy transfer, and microbial ecosystems. Also, controlling fate and transport of hazardous materials, with emphasis on chemical equilii

about by emulsion-breaking chemicals and gravity and flotation oil-water separators; 3) phase and species transformations through pH neutralization, chemical precipitation, chemical oxidation and/or reduction, air stripping, and solidification and/or stabilization; and 4) solute separation and concentration achieved with activated carbon absorption, synthetic ion exchange resins, and membrane separation techniques.

CEE 5322/CEE 7322 (3). BIOLOGICAL WASTE TREATMENT. Topics include an overview of microbiology and microbial metabolism, the kinetics of biological growth, and aerobic suspended growth processes, including the various modifications of the activated sludge process, aerated lagoons, and sequencing batch reactors. Also, aerobic attached growth processes such as trickling filters, biofilter towers, and rotating biological contactors. Covers anaerobic processes, including sludge digestion and liquid waste treatment with the anaerobic contact process and anaerobic filters. Examines biosolids handling and disposal, composting, land treatment, in situ biotreatment, and biotreatment of contaminated soils.

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

CEE 5325/CEE 7325 (3). DISASTER MANAGEMENT. Introduction to basic concepts in disaster management and to key methods in the field, including simulation modeling, consequence analysis tools, design criteria, statistical and case study methods (lessons learned), and risk analysis. Students draw on a range of sources (the textbook, the U.S. National Response Plan, research papers, etc.) to explore the fundamentals of preparedness, mitigation, response, and recovery. An all-hazards approach is taken, providing analysis of natural, technological, and man-made disasters.

management, fate and transport of pollutants in the environment, regulations of air quality, and the operation and design of air pollution control systems. Reviews the status of science, policy, and regulations on several selected topics such as urban smog, regional haze, greenhouse gas and global climate change, stratospheric ozone depletion, and mercury emissions and control. *Prerequisites:* CHEM 1304, MATH 1337 or equivalent, and PHYS 1303 or equivalent.

ronmental exposures, and the strengths and limitations of research strategies and interpretation of study results. Includes air and water pollution, lead, and biological marker outcomes.

CEE 5354/CEE 7354 (3). ENVIRONMENTAL ENGINEERING PRINCIPLES AND PROCESSES. Introduces waste minimization and pollution prevention techniques and objectives. Includes a comprehensive study of biological, chemical, and physical principles and treatment strategies for controlling pollutant emissions, with equal emphasis on underlying theory and practical engineering application of both common and innovative water and wastewater treatment processes. Includes rigorous derivation of design equations, procedures, and process models for chemical and/or biological reactors and physical unit operations. Places emphasis on engineering analysis and application of process modeling techniques for design of unit processes to achieve specific treatment objectives. *Prerequisites:* CHEM 1303, CEE 2304, CEE/ME 2342, and MATH 2343.

CEE 5361/CEE 7361/ME 7361/ME 5361 (3). MATRIX STRUCTURAL ANALYSIS AND INTRODUCTION TO FINITE ELEMENT METHODS. A systematic approach to the formulation of force and displacement method of analysis, the representation of structures as assemblages of elements, and computer solution of structural systems. *Prerequisite:* CEE/ME 3350 or permission of instructor.

CEE 5362/CEE 7362 (3). ENGINEERING ANALYSIS WITH NUMERICAL METHODS. Applications of numerical and approximate methods in solving engineering problems. Prerequisite: MATH 2343.

sites: Undergraduate introduction to electrical circuits, classical mechanics, and fluid dynamics or instructor approval.

CEE 5370/CEE 7370 (3). FACILITY PLANNING. Covers the overall planning process for construction projects and presents the three divisions of planning (program planning, project planning, and activity planning) in an integrated manner. Includes different modeling approaches for the planning process.

CEE 5383/CEE 7383/ME 5383/ME 7383 (3). 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. Emphasizes theory and analysis. *Prerequisites:* CEE/ME 2331, 2342; ME 3332.

CEE 5384/CEE 7384 (3). ENERGY MANAGEMENT FOR BUILDINGS. Examines procedures to select energy savings options for buildings, with emphasis on the practical aspects of the subject. Considers space planning, architectural considerations, cost, and environmental impact of the mechanical and electrical systems 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/CEE 7385 (3). ADVANCED SOIL MECHANICS. Physicochemical properties of soil and soil stabilization, advanced theories of soil deformation and failure as applied to slope stability and lateral loads, and soil and water interaction in earthen dams. *Prerequisite:* CEE 3385.

CEE 5386/CEE 7386 (3). FOUNDATION ENGINEERING. Covers the application of soil mechanics principles to the design and construction of shallow and deep foundations. Topics include subsurface investigation procedures to obtain soil parameters for design and construction of structure foundations, bearing capacity and settlement analyses, construction procedures, and soil improvement techniques. *Prerequisite:* CEE 3385.

CEE 5387/CEE 7387 (3). GEOTECHNICAL EARTHQUAKE ENGINEERING. Provides fundamental knowledge and practical application of soil dynamics and geotechnical earthquake engineering. Includes an overview of seismic hazards, the fundamentals of vibration, wave propagation in an elastic medium, the properties of dynamically loaded soils, earthquake-induced ground motion, ground response analysis, lateral earth pressure on retaining walls, the liquefaction of soils, and seismic stability of earth embankments. *Prerequisite:* CEE 5364 or

COMPUTER SCIENCE AND ENGINEERING

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

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

General Information

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 large-scale integration computer-aided design methods, bioinformatics, computer networks, data and network security, mobile computing, theory of computation, and computer arithmetic. The educational objectives of the undergraduate programs in the CSE Department are to produce graduates who become productive

- The ability to use the techniques, skills and modern computing and software engineering tools necessary for computing practice.

For graduates with degrees in computer engineering

- The ability to apply knowledge of mathematics, science and engineering to software and hardware design problems.
- The ability to design and conduct experiments and to analyze and interpret data related to software and hardware design solutions.
- 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.
- The ability to function on multidisciplinary teams using current computer engineering tools and technologies.
- The ability to identify, formulate and solve engineering problems based on a fundamental understanding of concepts of computer engineering topics.
- An understanding of personal, professional and ethical responsibility.
- The ability to communicate effectively both in an oral and written form.
- The broad liberal arts education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.
- The recognition of the need for and the ability to engage in lifelong learning.
- A knowledge of contemporary issues in computer engineering.
- 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, www.abet.org. The undergraduate computer science program that awards the degree Bachelor of Science is accredited by the Computing Accreditation Commission of ABET. The undergraduate computer science program that awards the degree Bachelor of Arts is not accredited by a Commission of ABET.

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. Other dual majors can be arranged in consultation with an adviser.

4+1 Master's Degree Program

The 4+1 Program allows students to complete both B.S. and M.S. degrees in five years. In the CSE Department, students may participate in the 4+1 Program in either the computer science or computer engineering area. Up to nine total credit hours of

Many of the computer science core courses (CSE 2341, 3345, 3353, 4345, 4351 and 4352) contain major project-oriented components to prepare students for apply-

Requirements for the Major (continued)	*Credit Hours*
Computer Science	47
CSE 1341, 1342, 2240, 2341, 3330, 3339, 3342, 3345, 3353, 3381, 4344, 4345, 4351, 4352, 4381, 5343	
Tracks and Electives	9–18
Research (9 credit hours)	
CSE 4397, 5350	
3 credit hours of track electives approved by adviser	
Data-Intensive Computing (9 credit hours)	
CSE 5330, 5331	
3 credit hours of track electives approved by adviser	
Software Engineering (9 credit hours)	
CSE 5314, 5319	
3 credit hours of track electives approved by adviser	
Game Development (18 credit hours)	
CSE 4051 (but not CSE 4351, 4352 from the list above)	
HGAM 5200, 5201, 5202, 5221, 5222, 5292, 5311, 5312 (Must be admitted to Guildhall Professional Certificate program and attend class at The Guildhall at SMU.)	
Security (9 credit hours)	
CSE 5339, 5349	
3 credit hours of track electives approved by adviser	
General (9 credit hours)	
Three 3-hour, 4000-level or above CSE courses approved by adviser	
Engineering Leadership	6
CEE 3302, EMIS 3308, *or* CSE 5317	
CSE 4360	
Electives	6
Advanced electives in the Lyle School of Engineering.	
	100–103

Note: Students choosing the game development track do not take CSE 4351 and 4352 and have a total degree requirement of 103 hours.

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

In addition to the Universitywide 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 Major	*Credit Hours*
Mathematics and Science	56
MATH 1337, 1338, 3353	
CSE 2353, 3365 (MATH 3315) or MATH 3316, CSE 4340 (Students may fulfill the CSE 4340 requirement by taking any one of CSE/STAT 4340, EMIS 3340, *or* STAT 5340.)	
BIOL 1401, 1402, 3304, 3350	

Requirements for the Major (continued)	Credit Hours
Computer Science	44
CSE 1341, 1342, 2240, 2341, 3330, 3342, 3345, 3353, 3381, 4344, 4345, 4351, 4352, 4381, 5343	

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, a grade of at least 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. *Prerequisite or corequisite:* C- or better in CSE 1341.

CSE 2341 (3). DATA STRUCTURES. Emphasizes the object-oriented implementation of data

CSE 4051 (0). GAMING DESIGN PROJECT. Requires students enrolled in HGAM 5292 to produce appropriate reports and other design documentation material resulting from their HGAM 5292 design experience, including design requirements, specifications, test plans, and other relevant documentation as required for assessing the design experience. *Corequisite:* HGAM 5292.

CSE 4090 (0). SENIOR PROJECT.

CSE 4190 (1). 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 4191 (1). 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 4192 (1). 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 4193 (1). 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 4194 (1). 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 4197 (1). 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 4290 (2). 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 4291 (2). UNDERGRADUATE SEMINAR. An opportunity for the advanced undergradu-thef the sup

CSE 4493 (4). UNDERGRADUATE PROJECT. An opportunity for the advanced undergraduate

execute: managers who must support the CM efforts; project managers who must plan and design the CM system for their projects; those who implement the system; those who manage and administer the system; and the testers, engineers, and quality assurance personnel who are affected by the system. *Prerequisites:* CSE major and junior, senior, or graduate-level standing.

CSE 5314 (3). SOFTWARE TESTING AND QUALITY ASSURANCE. Examines the relationship of software testing to quality, with an emphasis on testing techniques and the role of testing in the validation of system requirements. Topics include module and unit testing, integration, code inspection, peer reviews, verification and validation, statistical testing methods, error prevention and detection, project metrics selection and implementation, testing principles, formal models of testing, and performance monitoring, and measurement. Also, defining test plans and strategies

concepts of stemming, tokenizing and inverted indices, text similarity

Covers programming models for cloud computing, the fundamentals of virtualization technologies that enable scalability, and an introduction to the security and energy efficiency challenges

CSE 5369/CSE 7369 (3). HARDWARE SECURITY AND TROJAN DETECTION. Introduces

1. **Biomedical Engineering.** Overview of biomedical engineering, biomedical devices and instrumentation, biomedical signal capture, processing, and modeling.
2. **Communications and Information Technology.** Detection and estimation theory, digital communications, computer networks, spread spectrum, cellular communications, coding, encryption, compression, and wireless and optical communications.
3. **Control Systems.** Linear and nonlinear systems control, robotics, and computer and robot vision.
4. **Digital Signal Processing.** Digital filter design, system identification, spec-

network. The backbone within the Engineering School is connected to both the Internet 2 and the campus network that is then connected to the Internet at large. In addition to servers and shared computational resources, the Lyle School of Engineering maintains a number of individual computing laboratories associated with the departments. Specific department laboratory facilities for instruction and research include the following:

testbeds that operate from 400 MHz to 6 GHz for IEEE 802.11, cellular, and Bluetooth network and protocol development; and 3) diverse mobile phones and tablets that enable participatory sensing, context-aware applications and large-scale deployment in the field. The in-lab infrastructure is also enhanced by multiple outdoor antennas deployed on campus buildings and buses for understanding real wireless channels.

Semiconductor Processing Cleanroom. The 2,800 square-foot cleanroom, consisting of a 2,400 square-foot, class 10,000 room and a class 1,000 lithography area of 400 square feet, is located in the Jerry R. Junkins Engineering Building. A partial list of equipment in this laboratory includes acid and solvent hoods, photoresist spinners, two contact mask aligners, a thermal evaporator, a plasma asher, a plasma etcher, a turbo-pumped methane hydrogen reactive ion etcher, a four-target sputtering system, a plasma-enhanced chemical vapor deposition reactor, a diffusion-pumped four pocket e-beam evaporator, an ellipsometer, and profilometers. Other equipment includes a boron-trichloride reactive ion etcher, a chemical-assisted ion-beam etcher and a four-tube diffusion furnace. The cleanroom is capable of processing silicon, compound semiconductors and piezo materials for microelectronic, photonic and nanotechnology devices.

Submicron Grating Laboratory. This laboratory is dedicated to holographic grating fabrication and has the capability of sub 10th-micron lines and spaces.

lasers, single element 1-D and 2-D detector arrays, and a large complement of optical and optomechanical components and mounting devices. In addition, the laboratory has extensive data acquisition and analysis equipment, including an IEEE 1394 FireWire-capable image capture and processing workstation, specifically designed to evaluate the electrical and optical characteristics of smart pixel devices and FSOI fiber-optic modules. Support electronics hardware includes various test instrumentation, such as arbitrary waveform generators and a variety of CAD tools for optical and electronic design, including optical ray trace and finite difference time domain software.

Curriculum in Electrical Engineering

General Sequence or Specialization 24

General Sequence:

CSE 1341, 1342
One of EMIS 3308, 3309; CEE 3302; CSE 4360
One of ME 2310, 2320, 2331, 2342; CSE 2341, 2353; *or* any 5000-level EE course approved by adviser
One of EE 5356, 5357, 5381, 5385, 5387
One of EE 5310, 5312, 5314, 5321, 5330, 5332, 5333
One of EE 5360, 5362, 5370, 5371, 5372, 5373, 5374, 5375, 5376, 5377, 5378, 5379
3 hours from any EE or CSE 5000-level course selected with adviser's approval

Engineering Leadership Specialization:

CSE 1341, 1342
Three of EMIS 3308, 3309; CEE 3302; CSE 4360
One of EE 5356, 5357, 5381, 5385, 5387
One of EE 5310, 5312, 5314, 5321, 5330, 5332, 5333
One of EE 5360, 5362, 5370, 5371, 5372, 5373, 5374, 5375, 5376, 5377, 5378, 5379

Computer Engineering Specialization:

CSE 1341, 1342, 2341, 2353, 3353
EE 5381, 5385
One of EE 5357, 5387 or CSE 5343

Smart Wireless and Embedded Systems Specialization:

CSE 1341, 1342, 2341, 2353
Two of EE 5330, 5333, 5357, 5378, 5379, 5381, 5387

Requirements for the Major	*Credit Hours*
Mathematics and Science	34
MATH 1337, 1338, 2339, 2343, 3315, 3337, 3353 One of MATH 5315, 5325, 5331, 5332, 5334 CHEM 1303 PHYS 1303, 1304; 1105 *or* 1106	
Computer Science	6
CSE 1341, 1342	
Core Electrical Engineering	24
EE 1322, 1382, 2322/2122, 2350, 2370/2170, 2381/2181, 3360	
Junior Electrical Engineering Courses	20
EE 3311, 3322/3122, 3330, 3352, 3372, 3381/3181	
Advanced Electives	12
One of EE 5360, 5362, 5370, 5371, 5372, 5373, 5374, 5375, 5376, 5377, 5378, 5379 One of EE 5356, 5357, 5381, 5385, 5387 One of EE 5310, 5312, 5314, 5321, 5330, 5332, 5333 3 hours from any EE or CSE 5000-level course approved by adviser	
Senior Design Sequence	6
EE 4311, 4312	
	102

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 inte-

EE 3122 (1). EE LABORATORY: ELECTRONIC CIRCUITS II. Experiments in analog electronic circuit design. *Prerequisites:* C- or better in EE 2122, 2322. *Corequisite:* EE 3322.

EE 3181 (1). EE LABORATORY: MICROCONTROLLERS AND EMBEDDED SYSTEMS. Fundamentals of microprocessor design, assembly language programming, and embedded system implementation. Students study a widely used family of microprocessors for microcontroller-based system design, assembly-level programming, and hardware interfacing. *Prerequisites:* C- or better in EE 2181, 2381. *Corequisite:* EE 3381.

EE 3190 (1). JUNIOR PROJECT.

EE 3290 (2). JUNIOR PROJECT.

EE 3311/EE 7322 (3). SOLID-STATE DEVICES. A laboratory-oriented elective course that introduces the working principles of semiconductor devices by fabricating and testing silicon MOSFET transistors and III–V based semiconductor lasers in the SMU cleanroom. Lectures explain the basic operation of diodes, bipolar transistors, field effect transistors, light-emitting diodes, semiconductor lasers, and other photonic devices. Additional lectures discuss the basics of device processing, which include photolithography, oxidation, diffusion, ion-implantation, metalization, and etching. Laboratory reports describing the fabrication and testing of devices account for a major portion of the course grade. *Prerequisites:*

EE 4196 (1). SENIOR THESIS. *Prerequisite:* Admission to the departmental distinction program.

EE 4296 (2). SENIOR THESIS. *Prerequisite:* Admission to the departmental distinction program.

EE 4311 (3). SENIOR DESIGN I.

and GRATING. Includes peer review before final submission of a laboratory report describing the projects. *Prerequisite:* EE 3311 or equivalent.

EE 5313 (3). SOLAR CELLS AND APPLICATIONS. This laboratory-oriented course explores the sun's energy as a source of electrical power and the working principles of silicon and III–V solar cells. Covers characteristics of the sun, semiconductor properties, p-n junctions, solar cell fabrication, and photovoltaic system design. Students fabricate and test silicon solar cells in the SMU cleanroom. Lectures and class discussions explain the basic operation of p-n junction diodes and solar cells along with the basics of device processing, including photolithography, oxidation, diffusion, ion implantation, metallization, and etching. *Prerequisite:* EE 3311 or permission of instructor.

EE 5314 (3). INTRODUCTION TO MICROELECTROMECHANICAL SYSTEMS. Develops the basics for MEMS, including microactuators, microsensors, and micromotors; principles of operation; micromachining techniques (surface and bulk micromachining), IC-derived micro-fabrication techniques; and thin Im technologies as they apply to MEMS. *Prerequisite:* EE 3311.

EE 5321 (3). SEMICONDUCTOR DEVICES AND CIRCUITS. A study of the basics of CMOS integrated analog circuits design. Topics include MOSFET transistor characteristics, DC biasing, small-signal models, different amplifiers, current mirrors, single- and multi-stage electronic amplifiers, frequency response of electronic amplifiers, amplifiers with negative feedback, and

EE 5357 (3). CAE TOOLS FOR STRUCTURED DIGITAL DESIGN. Concentrates on the use of CAE tools for the design and simulation of complex digital systems. Discusses and uses Verilog hardware description language for behavioral and structural hardware modeling. Emphasizes structured modeling and design. Design case studies include a pipelined processor, cache memory, UART, and a floppy disk controller. *Prerequisites:* C- or better in EE 2381 and junior standing, or permission of instructor.

EE 5360 (3). 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.

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 si

EE 5378 (3). MOBILE PHONE EMBEDDED DESIGN. Students learn to develop embedded software for the most widely used smartphone platforms, with emphasis on wireless and sensing applications. Topics include user interface design such as multitouch 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 (e.g., controlling memory leaks, object allocation, and multithreading). Draws from various fields, including wireless communications and networking, embedded programming, and computer architecture.

EE 5379 (3). OPTIMIZATION IN WIRELESS NETWORKS. Covers a wide variety of optimization problems in the design and operation of wireless networks. Introduces basic linear programming and integer linear programming concepts and explains these concepts using examples from wired and wireless networks. Also, the basic structure and design of various wireless networks, including cellular networks (such as GSM) and wireless LANs (e.g., those based on 802.11g/n). *Prerequisite:* EE 2170 or equivalent, or permission of instructor.

EE 5381 (3). DIGITAL COMPUTER DESIGN. Emphasizes design of digital systems and register transfer. Design conventions, addressing modes, interrupts, input-output, channel organization, high-speed arithmetic, and hardwired and microprogrammed control. Also, central processor organization design and memory organization. Each student completes one or more laboratory projects. *Prerequisites:* C- or better in EE 2181, 2381 and junior standing.

EE 5385/EE 7385/CSE 7385/CSE 5385 (3). MICROCONTROLLER ARCHITECTURE AND INTERFACING. Emphasizes the design and interfacing of microprocessor computer systems. Covers processor architecture and interfacing, memory structure and interfacing, bus systems, support chips, tools for hardware design, analysis, simulation, implementation, and debugging. Includes a laboratory that provides practical experience in designing and analyzing interfaces to processors, memories, and peripherals. *Prerequisites:* C- or better in CSE 3381 or in EE 3181, 3381.

EE 5387/CSE 5387 (3). DIGITAL SYSTEMS DESIGN. Modern topics in digital systems design, including the use of HDLs for circuit specification and automated synthesis tools for realization. Programmable logic devices are emphasized and used throughout the course. Includes heavy laboratory assignment content and a design project. *Prerequisite:* C- or better in EE 2381 or in CSE 3381.

EE 5390 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member. The department offers special topics courses with a range of credit hours; the last digit in the course number represents courses with different topics.

EE 5391 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member. The department offers special topics courses with a range of credit hours; the last digit in the course number represents courses with different topics.

EE 5392 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member. The department offers special topics courses with a range of credit hours; the last digit in the course number represents courses with different topics.

EE 5393 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member. The department offers special topics courses with a range of credit hours; the last digit in the course number represents courses with different topics.

EE 5395 (3). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member. The department offers special topics courses with a range of credit hours; the last digit in the course number represents courses with different topics.

EE 5490 (4). SPECIAL TOPICS. This special topics course must have a section number associated with a faculty member. The department offers special topics courses with a range of credit hours; the last digit in the course number represents courses with different topics.

Telecommunication Courses (EETS)

EETS 5301 (3). INTRODUCTION TO TELECOMMUNICATIONS. Overview of public and private telecommunications systems, traffic engineering, switching, transmission, and signaling. Also, channel capacity, media characteristics, Fourier analysis and harmonics, modulation, electromagnetic wave propagation and antennas, modems and interfaces, digital transmission systems, T1 carriers, digital microwave, satellites, fiber optics and SONET, and integrated services digital networks.

EETS 5302 (3). TELECOMMUNICATIONS MANAGEMENT AND REGULATION. Managerial sequel to EETS 5301 that provides a historical review of the most significant regulation and management issues affecting the telecommunications industry over the past 100 years. Students explore the regulatory environment the industry operates in today through the study of current events, articles, and recent state and federal legislation. *Prerequisite:* EETS 5301 (formerly EE 5301) or experience in the telecommunications industry.

EETS 5303 (3). FIBER OPTIC TELECOMMUNICATIONS. Introduction to the practical con-

ENGINEERING MANAGEMENT, INFORMATION AND SYSTEMS

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

Professors: Stephen A. Szygenda, Jeff Tian (Computer Science and Engineering). **Associate Professors:** Richard S. Barr, Eli V. Olinick, Jerrell T. Stracener. **Assistant Professor:** Michael Hahsler. **Senior Lecturers:** Leslie-Ann Asmus, Thomas F. Siems. **Lecturers:** Gretchen H. Coleman, Rachel P. Goodman. **Adjunct Faculty:** Karl J. Arunski, Chris L. Askew, John D. Baschab, Charles W. Beall, Robert L. Bell, William D. Bell, Ann E. Broihier, George W. Chollar, Randall J. Clendening, Howard S. Cowin, Christopher M. Davis, Dennis J.

Computing Facilities

Students in the EMIS Department have access to a wide range of computing facilities and networking equipment. The department manages three PC-based computing labs, including the Enterprise Systems Design Laboratory created for students in the

Science / Social Science (continued)	
Group 2:	
ANTH 2315, 2363	
CEE 1301, 1378	
CSE 1331	
EE 1301, 1382	
ME 1301, 1202/1102, 1303	
PHYS 1403, 1404	
Group 3: Other courses in ANTH, ECO, PSYC, or SOCI	
Major Concentration	45
EMIS 1360, 2360, 3308 (or MNO 3370), 3309, 3340, 3360, 3361, 4395, 5362	
CEE 3302	
CSE 1341, 1342, 4360	
6 hours from EMIS courses at the 5000 level or above	
Business	6
ACCT 2301 and MKTG 3340	
Electives	15
Adviser must approve electives.	
	93

Note: All management science majors must earn a grade of at least *C-* in all courses taken in fulfillment of the requirements for the major; however, a grade of *C* or better is required in all subset classes. All courses must be taken for a grade (not pass/fail), with the exception of those courses for which the student has received test credit.

Minor in Management Science

For information on a minor in management science, the student should consult the department. The minor in management science operates concurrently with the B.S. degree. Students seeking a minor in management science must meet the same admission and subset requirements as students seeking a B.S. degree as described in the "Admission to Advanced Standing" section, and they will be enrolled in the same sections of courses as B.S. management science majors. A total of 15 term credit hours (in addition to the required subset courses) are required for the minor in

EMIS 5290 (2). SPECIAL TOPICS. Individual or group study of selected topics in management science. *Prerequisite:* Permission of instructor.

EMIS 5300/EMIS 7300 (3). SYSTEMS ANALYSIS METHODS. Introduction to modeling and analysis concepts, methods and techniques used in systems engineering, design of products and associated production, and logistics systems and analysis of operational system performance. Specific topics include probabilistic and statistical methods, Monte Carlo simulation, optimization techniques, applications of utility and game theory, and decision analysis.

EMIS 5301 (3). SYSTEMS ENGINEERING PROCESS. Examines the discipline, theory, economics, and methodology of systems engineering. Reviews the historical evolution of the practice of systems engineering and the principl

reliability modeling and analysis, system reliability design guidelines and analysis, system reliability test and evaluation, and maintaining inherent system reliability during production and operation.

EMIS 5332/EMIS 7332 (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. Reinforces all material covered 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 5335/EMIS 7335 (3). HUMAN SYSTEMS INTEGRATION. Advances the understanding and application of cognitive science principles, analysis-of-alternatives methods, and engineering best practices for addressing the role of humans within the design of high-technology systems. Presents and discusses HSI-specific processes such as task-centered design; human factors engineering; manpower, personnel, and training; process analysis; and usability testing and assessment. *Prerequisite:* EMIS 5301.

EMIS 5340 (3). LOGISTICS SYSTEMS ENGINEERING. Utilizes system engineering principles and analyses to introduce concepts, methods, and techniques for engineering and development of logistics systems associated with product production and manufacturing; product order and service fulfillment; and product, service, and customer support. Topics include logistics systems requirements, logistics systems design and engineering concurrently with product and service development, transportation and distribution, supply and material support, and supply Web design and management. Also, product, service, and customer support.

EMIS 5347/EMIS 7347 (3). CRITICAL INFRASTRUCTURE PROTECTION AND SECURITY SYSTEMS ENGINEERING. Presents SE concepts as applied to the protection of the United

a simulation language. *Prerequisites:* Programming ability and knowledge of introductory probability or statistics.

EMIS 5362/EMIS 7362 (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/EMIS 7364 (3). STATISTICAL QUALITY CONTROL. A comprehensive introduction to the statistical quality control methods that underlie the modern quality revolution. Uses statistics and simple probability to develop control charts to monitor and improve the quality of an ongoing process, and for acceptance-sampling plans (including MIL-STD). Defines control charts for attributes, variables, and CUSUM procedures and applies them to everyday problems in manufacturing and service businesses. *Prerequisite:* EMIS 3340 (STAT/CSE 4340), EMIS 5370, or STAT 5373.

EMIS 5365/EMIS 7365 (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/EMIS 7366 (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 3360 or equivalent, and EMIS 3340 (STAT/CSE 4340) or EMIS 5370.

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 and 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/EMIS 7377 (3). STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS. Introduces statistical principles in the design and analysis of industrial experiments. Covers 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; and mean comparisons. *Prerequisites or corequisites:* C- or better in EMIS 4340 and senior standing with a science or engineering major, or permission of instructor.

EMIS 5380 (3). MANAGING INFORMATION TECHNOLOGY CONTROLS. Surveys current practices in IT governance and controls, with approaches for balancing business needs with technology controls for high-risk processes. Topics include introduction to technology controls, the process of IT governance, sy

MECHANICAL ENGINEERING

Professor Ali Beskok, **Chair**

Professors: Ali Beskok, Yildirim Hürmüzlü, Radovan B. Kovacevic, Paul S. Krueger, José L. Lage, M. Volkan Otugen, Peter E. Raad, Wei Tong. **Associate Professors:**

In combination with a solid liberal arts foundation, 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 found success in graduate school and in employment, and regularly attain graduate degrees in engineering, medicine, business and law. Graduates are employed as engineers or consulting engineers for major engineering, pharmaceutical, environmental, financial, banking and real estate companies.

The undergraduate program in mechanical engineering is accredited by the Engineering Accreditation Commission of ABET, www.abet.org.

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

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

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

The Mechanical Engineering Department offers the following undergraduate degrees:

Bachelor of Science in Mechanical Engineering

Bachelor of Mechanical Engineering and Bachelor of Science with a major in math (dual degrees)

Bachelor of Mechanical Engineering and Bachelor of Science with a major in physics (dual degrees)

Bachelor of Science in Mechanical Engineering (with a minor in business administration)

Bachelor of Science in Mechanical Engineering (with a premedical/biomedical specialization)

Bachelor of Science in Mechanical Engineering (with an engineering management and entrepreneurship specialization)

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

Departmental Facilities

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

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

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

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

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

Micro, Nano and Biomechanics of Materials Laboratory. This laboratory supports research primarily in the area of solid mechanics and materials engineering, with a focus on the combined experimental characterization as well as .6(d)-1.987(e)-.4(r

tion for sensor development in the microsize level with a nanolevel 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.

Instructional Laboratories

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

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

Computational / Design Laboratory. Dedicated computational f(na)-7.ttdd

Requirements for the Major (continued)	Credit Hours
Tracks (continued)	
Thermofluids Track	
Required: ME 3341, 4338, 5330	
Electives: One from ME 3360, 5331, 5332, 5333, 5337, 5371, 5383, 7336	
One from dynamics and controls required or elective courses	
One from solid mechanics, materials, and manufacturing required or elective courses	
Dynamics and Controls Track	
Required: ME 5302, 5320, 5322	
Electives: One from ME 3360, 5326, 5364, 5376	
One from thermofluids required or elective courses	
One from solid mechanics, materials, and manufacturing required or elective courses	
Solid Mechanics, Materials, and Manufacturing Track	
Required: ME 4370, 5319, 5338	
Electives: One from ME 5321, 5323, 5324, 5340, 5341, 5357, 5361	
One from thermofluids required or elective courses	
One from dynamics and controls required or elective courses	

include the completion of a minimum of 120 academic credit hours for any degree, the credit hour requirements within this curriculum are distributed as follows:

Requirements for the Major	*Credit Hours*
Mathematics and Science	58
MATH 1337, 1338, 2339, 2343, 3353 STAT 4340 *or* equivalent CHEM 1303 PHYS 1303/1105, 1304/1106, 3305, 3344, 3374, 4211, 4321, 4392, 5382, 5383 Two advanced physics electives	
Engineering	53
ME 1302, 2310, 2331/2131, 2340/2140, 2342/2142, 3332/3132, 3340, 3370, 4338, 4360/4160, 4370, 4380, 4381, 5322; CSE 1341; EE 2350	
	111

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

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

The Mechanical Engineering Department offers a B.S.M.E. degree with a premedical/biomedical specialization. This program enables students to satisfy the premedical or predental requirements for admission to medical or dental school, while at the same time satisfying the requirements for an accredited degree in mechanical engineering. In addition to the Universitywide requirements, which include the completion of a minimum of 120 academic credit hours for any degree, the credit hour requirements within this curriculum are distributed as follows:

Requirements for the Specialization	*Credit Hours*
Mathematics and Science	56
MATH 1337, 1338, 2339, 2343, 3353 STAT 4340 *or* equivalent BIOL 1401, 1402, 3304, 3350 CHEM 1303/1113, 1304/1114, 3371/3117, 3372/3118 PHYS 1303/1105, 1304/1106	
Engineering	

Minor in Mechanical Engineering

For approval of a minor in mechanical engineering, the student should consult the department. The five courses represent a minor that provides a broad introduction to mechanical engineering. Based on the student's interests and background, other sets of mechanical engineering courses may be substituted with the department's approval.

Requirements for the Minor	*Credit Hours*
Four from ME 2310, 2320, 2331, 2340, 2342 One from ME 3340, 3370	
	15

The Courses (ME)

ME 1301 (3). MACHINES AND SOCIETY. Introduces engineering systems to nonengineering students. Defines engineering, what engineers do, and what mechanical engineers do. Topics include the historical perspective on engineering design, principles of design engineering, energy conversion processes, engineered products, what mechanical engineers produce, the basic principles of converting science to technology, and the development of technology for society and humanity. Also, the laboratory and workshop experience, including computer animation and simulation.

ME 1302 (3). INTRODUCTION TO MECHANICAL ENGINEERING. Introduction to mechanical engineering and the engineering profession. Topics include forces in structures and fluids, conservation laws and thermal systems, motion of machinery, engineering design, and basic concepts in intellectual property for mechanical engineers. Also, topics in mechanical engineering as appropriate for current events.

ME 1303 (3). ENERGY, TECHNOLOGY, AND THE ENVIRONMENT. An elementary introduction to the ways energy is produced and distributed, energy resources, electrical power, heating and cooling, solar energy applications, and other topics related to people and the environment.

ME 1304 (3). GREEN ENGINEERING: DESIGNING TOMORROW TODAY. Presents how design choices for materials, manufacturing processes, energy usage, and end-of-life disposal affect economic and natural environments. Also, case studies in design for the environment for various industries. In lab, students use computer modeling to create designs and then analyze and compare the designs' total life cycle impact through eco-audits of energy and carbon footprints. Students also use software to compare and select materials best suited for a particular design and its constraints.

ME 1305 (3). INFORMATION TECHNOLOGY AND SOCIETY. A comprehensive survey of information technologies and the growing interconnectivity between them as currently utilized throughout society. Students 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. Discusses issues surrounding IT, including history, ethics, legal questions, use in producing and maintaining a competitive advantage, effects on society, and associated costs and benefits.

ME 2131 (1). THERMODYNAMICS LABORATORY. One 3-hour laboratory session per week. Basic thermal-property and power-device measurements to complement lecture material of ME 2331. Offered parallel to ME 2331. *Prerequisites:* MATH 1337 and sophomore standing.

ME 2140/CEE 2140 (1). 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, and the effect of stress concentrators. *Prerequisite or corequisite:* ME/CEE 2340.

ME 2142/CEE 2142 (1). FLUID MECHANICS LABORATORY. One 3-hour laboratory session per week. Experiments in fluid friction, pumps, boundary layers, and other flow devices to complement lecture material of ME 2342. *Prerequisite or corequisite:* ME/CEE 2342.

ME 2310/CEE 2310 (3). STATICS. Equilibrium of force systems, computations of reactions

productivity and quality of life of people working in the organization. Introduces industrial organizational psychology as applied to the manufacturing organization, with a focus on understanding individual behavior and experiences in industrial and organizational settings. Also introduces industrial psychology as it addresses the human resource functions of analyzing jobs and appraising, selecting, placing, and training people. Addresses the psychology of work, including employee attitudes, behavior, emotions, health, motivation, and well-being, as well as the social aspects of the workplace.

ties of the common hydraulic fluids to ascertain their influence on the behavior of typical fluid power system. Includes mathematical models of the individual components to aid in the simulation of a hydraulic system for a desired function. Also, introduces commercially available software for system simulation. The 1-hour lab allows students to gain hands-on experience with hydraulic systems.

ME 5330 (3). HEAT TRANSFER. Application of the principles of conduction, convection, and radiation heat transfer. Topics include steady and unsteady state, special configurations, numerical and analytical solutions, and design. *Prerequisite:* ME 3332 or equivalent.

ME 5331 (3). ADVANCED THERMODYNAMICS. Laws of thermodynamics, availability, irreversibility, real gases and mixtures, thermodynamic relations and generalized charts, combustion, chemical and phase equilibrium, and computational combustion. *Prerequisites:* ME/CEE 2331, 2342.

ME 5332 (3). HEAT TRANSFER IN BIOMEDICAL SCIENCES. Fundamentals of heat transfer in medicine and biology, biothermal properties, thermal regulation processes, and biomedical heat transfer processes with applications in tissue laser radiation, freezing and thawing of biological materials, cryosurgery, and others. *Prerequisites:* ME/CEE 2342 and ME 3332, or consent of instructor.

ME 5333 (3). TRANSPORT PHENOMENA IN POROUS MEDIA. Covers fractals and their role in characterizing complex structures and the fundamental concepts of momentum, heat, and mass transport through heterogeneous (e.g., composite, porous) materials, with emphasis on the mathematical modeling of heat and mass transfer in heterogeneous and fully saturated systems. Presents relevant industrial and natural applications throughout the course. *Prerequisites:* ME/CEE 2342 and ME 3332, or consent of instructor.

ME 5334 (3). FUNDAMENTALS OF ELECTRONIC PACKAGING. Introduces microsystems packaging and covers the role of packaging in microelectronics, the role of packaging in microsystems, electrical package design, design for reliability, thermal management, single- and multi-chip packaging, IC assembly, passive devices, optoelectronics, RF packaging, MEMS, sealing and encapsulation, system-level PWBs, PWB assembly, packaging materials and processes, and microsystem design for reliability.

ME 5335/ME 7335 (3). CONVECTIVE COOLING OF ELECTRONICS. Reviews the fundamental concepts of convection heat transfer and applications of these principals to the convective cooling of electronic components and systems, with emphasis on the design of natural and forced convection heat sinks with air and liquid cooling, fan and pump selection procedures (e.g., piezoelectric fans and micropumps), acoustic fan noise and noise measurement techniques, augmentation of convection heat transfer in the form of plate-fin and pin-fin extended surfaces, spray cooling, jet impingement cooling, microchannel cooling, heat pipes, and capillary pumped loops. Covers pool boiling and flow boiling as applied to the thermal management of electronics, and the design of electronic chassis with flow through coldwalls and edge-cooled PWBs. Uses several industry-related applications as examples. *Prerequisite:* ME 3332.

ME 5336 (3). INTERMEDIATE FLUID DYNAMICS. Reviews fundamental concepts of undergraduate fluid mechanics and introduces advanced fluid dynamics, including irrotational flow, tensor notation, and the Navier-Stokes equations. *Prerequisite:* ME/CEE 2342 or equivalent.

ME 5337/ME 7337 (3). INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS. Concepts of stability, convergence, accuracy, and consistency; applications to linear and nonlinear model partial differential equations; curvilinear grid generation; and advanced topics in grid generation. Also, the Beam-Warming factored implicit technique; MacCormack techniques; and solution methods for the Reynolds equation of lubrication, the boundary layer equations, and the Navier-Stokes equations. *Prerequisites:* ME 2342 or equivalent, MATH 2343 or equivalent, or permission of instructor.

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

ME 5341 (3). STRUCTURAL PROPERTIES OF SOLIDS. Develops an understanding of the structural aspect of solids and their relationship to properties and applications. Topics include structural defects, bonding and crystal structure, solid-state reactions and phase transformations, degradation, and deformation. *Prerequisite:* ME 3340 or permission of instructor.

ME 5342/ME 7342 (3). INTRODUCTION TO THERMAL MANAGEMENT OF ELECTRONICS. Emphasizes the thermal design of electronic packages and systems. Topics include the basics of conduction, convection (natural and forced), radiation heat transfer. Also, pool boiling and flow boiling, extended surfaces as applied to the design of heat exchangers and cold plates, and thermal interface resistance as applied to the design of electronic packages. Introduces modern cooling technologies such as single-phase cooling and two-phase cooling, heat pipes, and thermoelectric coolers. *Prerequisite:* ME 3332.

ME 5343/ME 7343 (3). ELECTRONIC PACKAGING MATERIALS: PROCESSES, PROPERTIES, AND TESTING. Focuses on an overview of materials used in electronic packaging. Examines solderability, microscopic processes, and alloy selection. Also, composites and applying conducting polymer matrix composites, metal films, and vacuum processes. Covers the importance of encapsulation, temperature humidity bias testing, and temperature cycle testing, as well as the measurement of properties of material in electronic packaging, thermal properties, physical properties, manufacturing properties, and materials selection. *Prerequisite:* ME 3340.

ME 5344/ME 7344 (3). CONDUCTIVE COOLING OF ELECTRONICS. Reviews the fundamental concepts of conduction heat transfer and applications of these principals to the conductive cooling of electronic components and systems, with emphasis on contact conductance, interface thermal resistance, heat spreaders, thermal interface materials, phase change materials, thermoelectric devices, Stirling cycle refrigerators, and the cooling of special electronic components such as multichip modules, power modules, high-density power supplies, and printed wiring boards. Features the thermal management by conduction of GaAs and GaN monolithic microwave integrated circuits). Employs steady-state and transient analyses, including 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. Develops the student's capability to characterize the mechanical and thermal performance of electronic devices and systems through the use of computational techniques. Commercial codes are used to create a thermal model of a fan-cooled, rectangular geometry, electronics chassis using direct air-cooling. Features additional computer codes for thermal modeling of heat transfer and fluid flow systems, and utilizes codes for the design of cold plates and heat exchangers. Students are exposed to concepts of structural modeling of components mounted on printed wiring boards in a vibration environment, and they analyze a number of industry-related problems, including first-level packages, printed wiring boards, and system-level electronics. At the end of the class, a student is expected to formulate and model a complex industry-based problem. *Prerequisites:* ME/CEE 2320, 2340 and ME 3332, 3340.

ME 5348/ME 7348 (3). THERMAL, FLUID, AND MECHANICAL MEASUREMENTS IN ELECTRONICS. Includes the following thermal and fluid measurement topics: the need for experimentation in electronic design; the use of similitude in electronics cooling, velocity, temperature, and pressure measurements; therma

ME 5357 (3). OPTIMIZED MECHANICAL DESIGN. Covers principles and methods for optimal design of machine elements (e.g., springs, shafts, gears, weldments of joints), mechanical systems (e.g., transmissions, cam systems, inertia loads and balancing), and computer applications. *Prerequisite:* ME 4370 or equivalent.

ME 5358 (3). DESIGN OF ELECTRONIC PACKAGING. A focus on thermal and mechanical design of electronic packaging. Fundamentals of heat transfer and fluid flow are applied to electronic packages and systems, including selection of fans, heat sinks, and other hardware important to good design. Mechanical designs of equipment that operates in more severe shock and vibration environments are developed using classical methods, with consideration given to selecting appropriate hardware. *Prerequisites:* ME/CEE 2320; MATH 2343, 3337.

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, and selection of fiber technologies. Also, 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.

two-dimensional flow method of characteristics. Also includes analysis of air-breathing propulsion systems and design of air-breathing propulsion systems components such as inlets and nozzles. *Prerequisites:* ME 2342, 2331.

ME 5372/ME 7372/ME 2372 (3). INTRODUCTION TO CAD.

MULTIDISCIPLINARY STUDIES

General Information

The Multidisciplinary Studies designation accommodates academic programs and courses that do not typically fit within the

ENGR 5093 (0). SPECIAL TOPICS.

ENGR 5297 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5298 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5299 (2). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5390 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5391 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5392 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5393 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5394 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5395 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5396 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5397 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5398 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

ENGR 5399 (3). SPECIAL TOPICS. Individual or group study of selected topics in engineering. *Prerequisite:* Permission of instructor.

Corequisite: ROTC 1180. Includes mandatory participation in individual physical fitness training, plus optional participation in a weekend field training exercise.

ROTC 2291 (2). CONFERENCE COURSE. Supplements the military science curricula through concentrated, independent study in a narrower field of military skill or subject matter. May be repeated for credit. Does not count for PE credit. *Prerequisite:* Permission of the PMS.

ROTC 2343 (3). LEADERSHIP TRAINING CAMP. A rigorous 5-week summer camp conducted at an Army post. Stresses leadership, initiative, and self-discipline. No military obligation incurred. Course completion qualifies the student for entry into the advanced course. Three different cycles offered during the summer, but spaces are limited by the Army. Candidates can apply for a space any time during the school year prior to the summer. Open only to students who have not taken all four of ROTC 1141, 1142, 2251, and 2252 and who pass an ROTC physical examination. P/F grade only.

ROTC 3341 (3). LEADERSHIP I. Development of ability to evaluate situations, plan and organize training, learn military tactics, review case studies in leadership management, and develop teaching and briefing skills. *Prerequisite:* Permission of PMS. *Corequisite:* ROTC 1180.

ROTC 3342 (3). LEADERSHIP II. Practical application of squad and platoon leadership in tactical situations, operation of small-unit communications systems, and development of the leaders' abilities to express themselves, analyze military problems, and prepare and deliver logical solutions. Demanding physical fitness training and performance-oriented instruction in preparation for summer field training. *Prerequisite:* Permission of PMS. *Corequisite:* ROTC 1180.

ROTC 3443 (4). NATIONAL ADVANCED LEADERSHIP CAMP. A 5-week, off-campus field training course stressing the practical application of leadership management, with emphasis on tactical and technical military field skills. Open only to students who have successfully completed ROTC 3341 and 3342. P/F grade only.

ROTC 3495 (4). NURSING ADVANCED SUMMER TRAINING. A 7-week, off-campus internship at a major U.S. Army hospital for ROTC nursing students. This nursing practicum provides hands-on experience that integrates clinical, interpersonal, and leadership knowledge and skills. Practical experience and familiarization with Army nursing in a variety of clinical tasks in the areas of medical-surgical nursing, pediatrics, obstetrics, and, in some cases, intensive care in ICUs in some cases. May be used for partial credit for NURS 3647 or 3347 with prior arrangement and approval of the dean of nursing. *Prerequisites:* Completion of the junior year of a baccalaureate nursing program and permission of the PMS.

ROTC 4341 (3). ADVANCED LEADERSHIP I. Stresses leadership qualities necessary for command and staff functions and operations. Stud Prerequisite: