Biomedical Engineering

**BMEN 1208** Introduction to Biomedical Engineering (2 semester hours) Project-based instruction. The purpose of this course is to give students a general understanding of the broad range of applications specific to the biomedical engineering profession. Course exercises include team-oriented competitions, lectures by various external biomedical engineering experts, and introductory materials associated with the discipline. Perform a competitive team design project. Prerequisite: **ECS 1200**. Prerequisites or corequisites: **PHYS 2325** and **PHYS 2125** and (**MATH 2419** or **MATH 2414**). (1-1) Y

**BMEN 2310** Static Equilibrium and Rigid Body Dynamics (3 semester hours) Lecture course. Course material includes static equilibrium of particles, trusses and machines. Friction equivalent systems, particle dynamics in one, two and three dimensions, work, energy, angular momentum and moment of inertia, and dynamics of rigid bodies. Prerequisites or corequisites: **ENGR 2300** and **MATH 2420**, and (**PHYS 2326** and **PHYS 2126**). (3-0) Y

**BMEN 2v99** Topics in Biomedical Engineering (1-4 semester hours) May be repeated as topics vary (9 hours maximum). ([1-4]-0) R

**BMEN 3101** Biomechanics Laboratory (1 semester hour) Laboratory course. Corequisite: **BMEN 3301**. Prerequisite: **RHET 1302**. (0-1) Y

**BMEN 3110** Biomedical Transport Processes Laboratory (1 semester hour) Laboratory course. Corequisite: **BMEN 3310**. Prerequisite: **RHET 1302**. (0-1) Y

**BMEN 3120** Biomedical Circuits and Instrumentation Laboratory (1 semester hour) Laboratory course. This course will include a brief recitation (discussion) session prior to each lab. Corequisite: **BMEN 3320**. Prerequisite: **RHET 1302**. (0-1) Y

**BMEN 3130** Engineering Physiology Laboratory (1 semester hour) Laboratory course. Corequisite: **BMEN 3330**; Prerequisite: **RHET 1302**. (0-1) Y

**BMEN 3150** Biomedical Engineering Laboratory (1 semester hour) Laboratory course. Corequisite: **BMEN 3350**. Prerequisite: **RHET 1302**. (0-1) Y

**BMEN 3301** Introduction to Biomechanics (3 semester hours) Mechanical properties of biological materials. The molecular basis for macroscopically measured quantities. Molecular mechanics (e.g. protein folding). Cellular mechanics of passive and active processes (e.g. cytoskeletal mechanics, cell migration). Simulation and numerical solution of dynamical equations arising in biomechanics. Corequisite: **BMEN 3101**. Prerequisite: **BMEN 2310**; Prerequisite or corequisite: **BMEN 1208**. (3-0) Y

**BMEN 3310** Fluid Mechanics and Transport Processes in Biomedical Engineering (3 semester hours) Introduction to fluid flow and transport phenomena in bioengineering. Fluids in biological circulatory systems, devices, and microsystems. Mass, thermal, and multiphase transport in biology. Emphasis on the use of mathematical modeling and computer simulations. Corequisite: **BMEN 3110**. Prerequisites: **ENGR 3300** and **BMEN 3301**. (3-0) Y
BMEN 3315  Thermodynamics and Physical Chemistry in Biomedical Engineering (3 semester hours) An introduction to the fundamentals of thermodynamics and physical chemistry. Molecules and chemical bonds, chemical kinetics and reaction equilibria. Topics also include molecular transitions, nonequilibrium processes, self assembly, and interface thermodynamics. Prerequisites: BMEN 1208 and (CHEM 1312 and CHEM 1112) and MATH 2420. (3-0) Y

BMEN 3320  Electrical and Electronic Circuits in Biomedical Engineering (3 semester hours) Introduction to analysis methods and network theorems used to describe operation of electric circuits. Electrical quantities, linear circuit elements, circuit principles, signal waveforms, transient and steady state circuit behavior, diode and transistor circuits, operational amplifiers, digital logic devices. Time domain and Laplace transform methods for analysis of electric circuits. Modeling, analysis and simulation of circuits. Corequisite: BMEN 3120; Prerequisites: MATH 2420 and (PHYS 2326 and PHYS 2126). (3-0) Y

BMEN 3330  Engineering Physiology of the Human Body (3 semester hours) An introduction to the physiology of the human body for engineers. This course will cover the various levels of structural organization of the body, from molecular, cellular and tissue/organ organization to the whole body anatomy and maintenance. The role of biological principles and phenomena will be highlighted in engineering terms. Corequisite: BMEN 3130. Prerequisites: (BIOL 2312 and BIOL 2112 and BIOL 2281) and BMEN 1208 and BMEN 3315. (3-0) Y

BMEN 3335  Biomedical Component and System Design (3 semester hours) Fundamental knowledge behind design of biomedical systems. Design and implementation of biomedical signal processing, Modeling and simulation for biomedical systems. Circuit and system design method for implantable devices. Software and hardware infrastructure for biomedical applications. Computer-aided techniques for analyzing sampled data. Corequisite: BMEN 3150; Prerequisites: BMEN 3301 and BMEN 3310. (3-0) Y

BMEN 4110  Biomedical Feedback Systems Laboratory (1 semester hour) Laboratory course. Corequisite: BMEN 4310. Prerequisite: RHET 1302. (0-1) Y

BMEN 4310  Feedback Systems in Biomedical Engineering (3 semester hours) Notions of inputs, outputs, and states. Linearity versus nonlinearity. Deterministic versus stochastic systems. Top down versus bottom up modeling. Sensitivity and reduction of sensitivity via feedback. Introduction to stability. Feedback for stabilization and disturbance rejection. Numerical simulation and controller design via computational approaches. Corequisite: BMEN 4110; Prerequisites: ENGR 2300 and MATH 2420. (3-0) Y

BMEN 4320  Intermediate Electrical Systems (3 semester hours) Principles of circuit and system analysis methods used in the design and analysis of biomedical instrumentation. Circuit solution methods. Filter design methods. Special emphasis is placed on circuits commonly employed in biomedical devices, such as amplifiers and filtering networks used in electrocardiograph systems, construction and characterization of simple transducers and signal conditioning equipment for measuring biomedical parameters such as force, displacement, pressure, flow and biopotentials. Prerequisites: BMEN 3320 and BMEN 3120. (3-0) Y

BMEN 4330  Advanced Engineering Physiology of the Human Body (3 semester hours) Advanced extension of BMEN 3330. This course will cover in-depth examples of the human physiology with engineering terms, with specific emphasis on synthetic biology approach to biological networks and systems biology approach to complex diseases, such as cancer and mental disorders. Prerequisite: BMEN 3330. (3-0) Y

BMEN 4350  Applied Sensor Technology (3 semester hours) Introduction to the basic principles and design
issues of biomedical sensors and instrumentation, including: the physical principles of biomedical sensors, analysis of biomedical instrumentation systems, and the application-specific biomedical sensor and instrumentation design. Topics include: basic concepts of sensors and instrumentation, membrane biophysics, action potentials, biopotential electrodes. Prerequisites: (BMEN 3320 and BMEN 3120) and (BMEN 3330 and BMEN 3130). (3-0) Y

**BMEN 4388** Senior Design Project I (3 semester hours) First of two sequential semesters devoted to a team project that engages students in the full engineering design process. The goal of senior design projects is to prepare the student to run/participate in engineering projects related to an appropriate industry. Thus, all project teams are to follow standard industrial practices and methods. Teams must carry the engineering project to completion, examining real world and multiple design constraints, following applicable industrial and business standards. Such constraints may include but are not limited to: economic, environmental, industrial standards, team time/resource management and cross-disciplinary/departmental result integration. Students are required to work in teams that include collaborative design interaction. Additionally, cross-disciplinary/departmental teams are encouraged but not required. In Senior Design I, project proposals will be written, reviewed and approved. Initial designs will be completed and corresponding constraints will be determined. All students will participate in a public oral and poster presentation following departmental approved guidelines at a departmental approved time and location. Teams will also submit a written end of semester progress report and documented team communication (complete sets of weekly reports and/or log books) following guidelines approved by the faculty. Prerequisites: BMEN 3315 and BMEN 3320 and BMEN 3330 and BMEN 3350 and ECS 3390. (3-0) Y

**BMEN 4389** Senior Design Project II (3 semester hours) Continuation of the Senior Design project begun in the previous semester. In Senior Design II, projects based on approved project proposals will be completed. All limitations of the design will be determined and addressed. All students will participate in a public oral presentation following faculty-approved guidelines at a faculty-approved time and location. Teams will also submit a written final report and documented team communication (complete sets of weekly reports and/or log books) following faculty-approved guidelines. Prerequisite: BMEN 4388. (3-0) Y

**BMEN 4399** Senior Honors in Biomedical Engineering (3 semester hours) For students conducting independent research for honors theses or projects. This course may be used as an honors course. (3-0) R

**BMEN 4v95** Undergraduate Topics in Biomedical Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 hours maximum). ([1-9]-0) R

**BMEN 4v97** Independent Study in Biomedical Engineering (1-9 semester hours) Independent study under a faculty member's direction. May be repeated for credit as topics vary (9 hours maximum). Instructor consent required. ([1-9]-0) R

**BMEN 4v98** Undergraduate Research in Biomedical Engineering (1-9 semester hours) May be repeated for credit as topics vary (9 hours maximum). This course may be used as an honors course. ([1-9]-0) R

**Computer Engineering**

**CE 1202** Introduction to Electrical Engineering (2 semester hours) CE 1202 introduces the discipline of engineering. It includes a 1.5-hour lecture per week plus a 3-hour fundamentals laboratory that stresses
learning about laboratory procedures and equipment. Topics include: Learning the use of common laboratory electronic equipment; understanding the assembly of electronic circuits; and making various measurements. Students also learn how to work together with a partner and how to write a laboratory report. The lecture introduces general engineering practices, engineering research at UTD, engineering activities at selected local companies, and concepts such as innovation and invention. The course also includes lectures and projects on communication, understanding the importance of lifelong learning, ethics, and a knowledge of contemporary issues. CE 1202 may be taken by students outside of engineering in order to learn about the engineering profession. (Same as EE 1202 and TE 1202) (1.5-3) S

**CE 1337 (COSC 1337)** Computer Science I (3 semester hours) Introduction to object-oriented software analysis, design, and development. Classes and objects. Object composition and polymorphism. Sorting, searching, recursion. Strings using core classes. Inheritance and interfaces. Graphical User Interfaces. Includes a comprehensive programming project. Prerequisite: CS 1336 with a grade of C or better or equivalent. (Same as CS 1337 and TE 1337) (3-0) S

**CE 2305 (MATH 2305)** Discrete Mathematics for Computing I (3 semester hours) Principles of counting. Logic and proof methods, including induction. Basic recurrence relations. Basics of algorithm complexity. Sets, relations, functions. Elementary graph theory. Elementary number theory. Students cannot get credit for both CE 2305 and (CE 3307 or TE 3307). Prerequisite: MATH 1326 or MATH 2413 or MATH 2417. (Same as CS 2305 and TE 2305) (3-0) S

**CE 2310** Introduction to Digital Systems (3 semester hours) Introduction to digital circuits, hardware structures, and assembly-language concepts that underlie the design of modern computer systems. Topics include: Internal data representation and arithmetic operations in a computer, basic logic circuits, MIPS assembly language and an overview of computer architecture. Some knowledge of a high-level language such as C++ or Java is expected. This class also has a laboratory component. Exercises will be assigned in class for completion in the laboratory. This class may be offered as either regular or honors sections (H). (Same as EE 2310) (3-1) S

**CE 2336 (COSC 2336)** Computer Science II (3 semester hours) Exceptions and number formatting. File input/output using Stream classes. Implementation of primitive data structures, including linked lists (all types), stacks, queues, and binary trees. Advanced data manipulation using core classes. Introduction to multi-threading, multimedia, and networking. Includes a comprehensive programming project. Prerequisite: CE 1337 or CS 1337 or TE 1337. Prerequisite or corequisite: CE 2305 or CS 2305 or TE 2305. (Same as CS 2336 and TE 2336) (3-0) S

**CE 2v99** Topics in Computer Engineering (1-4 semester hours) May be repeated as topics vary (9 hours maximum). ([1-4]-0) R

**CE 3101** Electrical Network Analysis Laboratory (1 semester hour) Laboratory to accompany CE 3301. Design, assembly and testing of linear electrical networks and systems. Use of computers to control electrical equipment and acquire data. Prerequisites: (CE 1202 or EE 1202 or TE 1202) and RHET 1302. Corequisite: CE 3301. (Same as EE 3101 and TE 3101) (0-1) S

**CE 3102** Signals and Systems Laboratory (1 semester hour) Laboratory based on MATLAB and LabVIEW to provide implementation experience on topics covered in CE 3302. Laboratory experiments cover linear time-invariant systems, convolution, Fourier series, continuous Fourier transform, sampling, discrete
Fourier transform, analog and digital filtering. Each lab is followed by a design application. Corequisite: **CE 3302**. Prerequisite: **RHET 1302**. (Same as **EE 3102** and **TE 3102**) (0-1) S

**CE 3310** Electronic Devices Laboratory (1 semester hour) Laboratory to accompany **CE 3310**. Experimental determination and illustration of properties of carriers in semiconductors including carrier drift, carrier diffusion; p-n junctions including forward and reverse bias effects and transient effects; bipolar transistors including the Ebers-Moll model and secondary effects; field effect transistors including biasing effects, MOS capacitance and threshold voltage. Corequisite: **CE 3310** or **EE 3310**. Prerequisite: **RHET 1302**. (Same as **EE 3110**) (0-1) S

**CE 3311** Electronic Circuits Laboratory (1 semester hour) Laboratory to accompany **CE 3311**. Design, assembly and testing of electronic circuits that use diodes, transistors and operational amplifiers in configurations typically encountered in practical applications. Corequisite: **CE 3311** or **EE 3311**. Prerequisite: **RHET 1302**. (Same as **EE 3111**) (0-1) S

**CE 3320** Digital Circuits Laboratory (1 semester hour) Laboratory to accompany **CE 3320**. Design, assembly, and testing of logic circuits. Use of programmable logic devices and simple CAD tools. Corequisite: **CE 3320** or **EE 3320**. Prerequisite: **RHET 1302**. (Same as **EE 3120**) (0-1) S

**CE 3301** Electrical Network Analysis (3 semester hours) Analysis and design of RC, RL, and RLC electrical networks. Sinusoidal steady state analysis of passive networks using phasor representation; mesh and nodal analyses. Introduction to the concept of impulse response and frequency analysis using the Laplace transform. Prerequisites: **MATH 2420** and **PHYS 2326**. Corequisite: **CE 3101**. (Same as **EE 3301** and **TE 3301**) (3-0) S

**CE 3302** Signals and Systems (3 semester hours) Introduces the fundamentals of continuous and discrete-time signal processing. Linear system analysis including convolution and impulse response, Fourier series, Fourier transform and applications, discrete-time signal analysis, sampling and z-transform. Prerequisite: **ENG 3300**. Corequisite: **CE 3102**. (Same as **EE 3302** and **TE 3302**) (3-0) S

**CE 3310** Electronic Devices (3 semester hours) Theory and application of solid state electronic devices. Physical principles of carrier motion in semiconductors leading to operating principles and circuit models for diodes, bipolar transistors, and field effect transistors. Introduction to integrated circuits. Prerequisite: **CE 3301** or **EE 3301** or **TE 3301**. Corequisite: **CE 3110** or **EE 3110**. (Same as **EE 3310**) (3-0) S

**CE 3311** Electronic Circuits (3 semester hours) Large-signal and small-signal characteristics of diodes, BJT and MOSFET transistors. Analysis of circuits containing diodes. Analysis of the DC and small-signal characteristics of single-stage BJT and MOSFET amplifiers. Analysis of circuits with an operational amplifier as a black box. Introduction of high-frequency models of BJT and MOSFET transistors and methods to analyze amplifier frequency response. Prerequisite: **CE 3310** or **EE 3310**. Corequisite: **CE 3111** or **EE 3111**. (Same as **EE 3311**) (3-0) S

**CE 3320** Digital Circuits (3 semester hours) Design and analysis of combinational logic circuits using basic logic gates and other building blocks like multiplexers and ROMs. Design and analysis of latches and flip-flops. Design and analysis of synchronous state machines. State minimization and introduction to state assignment. Design of datapath components: adders, multipliers, registers, shifters, and counters. Electrical properties of logic gates. Students cannot receive credit for both **CS 4341** and **CE 3320** or **EE 3320**. Prerequisite: **CE 2310** or **EE 2310**. Corequisite: **CE 3120**. (Same as **EE 3320**) (3-0) S
CE 3345 Data Structures and Introduction to Algorithmic Analysis (3 semester hours) Analysis of algorithms including time complexity and Big-O notation. Analysis of stacks, queues, and trees, including B-trees. Heaps, hashing, and advanced sorting techniques. Disjoint sets and graphs. Course emphasizes design and implementation. Students that completed CE 3346 or TE 3346 cannot receive credit for this course. Prerequisites: (CE 2305 or CS 2305 or TE 2305) and (CE 2336 or CS 2336 or TE 2336). Prerequisite or corequisite: CS 3341 or SE 3341 or ENGR 3341. (Same as CS 3345 and SE 3345 and TE 3345) (3-0) S

CE 3354 Software Engineering (3 semester hours) Introduction to software life cycle models. Software requirements engineering, formal specification and validation. Techniques for software design and testing. Cost estimation models. Issues in software quality assurance and software maintenance. Prerequisites: (CE 2336 or CS 2336 or TE 2336 or CS 3333), and (CE 2305 or CS 2305 or TE 2305 or equivalent). Prerequisite or corequisite: ECS 3390. (Same as CS 3354 and SE 3354) (3-0) S

CE 4304 Computer Architecture (3 semester hours) Introduction to computer organization and design, including the following topics: CPU performance analysis. Instruction set design, illustrated by the MIPS instruction set architecture. Systems-level view of computer arithmetic. Design of the datapath and control for a simple processor. Pipelining. Hierarchical memory. I/O systems. I/O performance analysis. Multiprocessing. Students cannot receive credit for both (CS 3340 or SE 3340 or TE 3340) and (CE 4304 or EE 4304). Prerequisite: CE 3320 or EE 3320. (Same as EE 4304) (3-0) S

CE 4337 Organization of Programming Languages (3 semester hours) Principles of design and implementation of contemporary programming languages. Formal description including specification of syntax and semantics of programming languages. Language definition structures including binding, scoping, data types, control structures, parameter passing, abstraction mechanism, and run-time considerations. Design issues of imperative languages, object-oriented languages, functional languages and logic languages. Design, implement, and debug programs in various programming language paradigms. Prerequisites: (CE 2336 or CS 2336 or TE 2336 or CS 3333) and (CE 2305 or CS 2305 or TE 2305) and (CS 3340 or SE 3340 or TE 3340 or CE 3340 or EE 4304). (Same as CS 4337) (3-0) S

CE 4348 Operating Systems Concepts (3 semester hours) An introduction to fundamental concepts in operating systems: their design, implementation, and usage. Topics include process management, main memory management, virtual memory, I/O and device drivers, file systems, secondary storage management, and an introduction to critical sections and deadlocks. Prerequisites: (CS 3340 or SE 3340 or TE 3340 or equivalent), and (CE 3345 or CS 3345 or SE 3345 or TE 3345), and a working knowledge of C and UNIX. (Same as CS 4348 and SE 4348 and TE 4348) (3-0) S

CE 4370 Embedded Microprocessor Systems (3 semester hours) An introduction to microprocessors and their uses. Features commonly found in a CPU are discussed, such as: The Program Counter, Stack, Status Register, General Purpose Registers, ALU, Instruction Set and peripheral devices. Memory (SRAM, DRAM, EPROM, EEPROM) and Memory Mapped IO Peripheral Devices. Assembly language is used to create the binary machine code necessary to program a Microprocessor system. The special features of microprocessors: the stack, interrupts, input ports, out ports and display. Prerequisites: (CE 3311 or EE 331 1) and (CE 3320 or EE 3320). Corequisite: CE 4304 or EE 4304. (3-1) Y

CE 4372 Contemporary Systems Design (3 semester hours) Design and analysis based system level design concepts, develop working projects using traditional and emerging technologies. Emphasis on specifying requirements, tracking projects and building test and validation strategies. Prerequisites: (CE 3320 or EE 33
CE 4388 Senior Design Project I (3 semester hours) First of two sequential semesters devoted to a team project that engages students in the full engineering design process. The goal of senior design projects is to prepare the student to run/participate in engineering projects related to an appropriate industry. Thus, all project teams are to follow standard industrial practices and methods. Teams must carry the engineering project to completion, examining real world and multiple design constraints, following applicable industrial and business standards. Such constraints may include but are not limited to: economic, environmental, industrial standards, team time/resource management and cross-disciplinary/departmental result integration. Students are required to work in teams that include collaborative design interaction. Additionally, cross-disciplinary teams are encouraged but not required. In Senior Design I, project proposals will be written, reviewed and approved. Initial designs will be completed and corresponding constraints will be determined. All students will participate in a public oral and poster presentation following departmental approved guidelines at a departmental approved time and location. Teams will also submit a written end of semester progress report and documented team communication (complete sets of weekly reports and/or log books) following guidelines approved by the faculty. Students must have completed ECS 3390 and one of the following prerequisite sequences: ((CE 3311 or EE 3311), and (CE 3320 or EE 3320), and (CE 3345 or CS 3345 or SE 3345 or TE 3345), and (CE 3354 or CS 3354 or SE 3 354)), or (((ENGR 3300 and (CE 3302 or EE 3302 or TE 3302), and (CE 3311 or EE 3311), and (CE 3320 or EE 3320)), or (((ENGR 3300 and (CE 3302 or EE 3302 or TE 3302), and (CE 3345 or CS 3345 or SE 3345 or TE 334 5)); prerequisite or corequisite: EE 3350 or TE 3350.] (Same as EE 4388 and TE 4388) (3-0) Y

CE 4389 Senior Design Project II (3 semester hours) Continuation of the Senior Design project begun in the previous semester. In Senior Design II, projects based on approved project proposals will be completed. All limitations of the design will be determined and addressed. All students will participate in a public oral presentation following faculty-approved guidelines at a faculty-approved time and location. Teams will also submit a written final report and documented team communication (complete sets of weekly reports and/or log books) following faculty-approved guidelines. Prerequisite: CE 4388 or EE 4388 or TE 4388. (Same as EE 4389 and TE 4389) (3-0) S

CE 4390 Computer Networks (3 semester hours) The design and analysis of computer networks. Topics include the ISO reference model, transmission media, medium-access protocols, LANs, data link protocols, routing, congestion control, internetworking, and connection management. Students cannot get credit for both (CE 4390 or CS 4390 or TE 4390) and EE 4390. Prerequisite: CE 3345 or CS 3345 or SE 3345 or TE 3345 or equivalent. (Same as CS 4390 and TE 4390) (3-0) S

CE 4399 Senior Honors in Computer Engineering (3 semester hours) For students conducting independent research for honors theses or projects. (0-3) R

CE 4v95 Undergraduate Topics in Computer Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 hours maximum). (1-9)-0 R

CE 4v97 Independent Study in Computer Engineering (1-9 semester hours) Independent study under a faculty member's direction. May be repeated for credit as topics vary (9 hours maximum). Instructor consent required. (1-9)-0 R

CE 4v98 Undergraduate Research in Computer Engineering (1-9 semester hours) Topics will vary from
semester to semester. May be repeated for credit as topics vary (9 hours maximum). Instructor consent required. ([1-9]-0) R

Computer Science

**CS 1136** *(COSC 1136)* Computer Science Laboratory (1 semester hour) Laboratory course to accompany **CS 1336**. This course assists students in experiencing elementary programming in a high-level language. This class cannot be used to fulfill degree requirements for majors in the School of Engineering and Computer Science. Corequisite: **CS 1336**. (0-2) S

**CS 1325** Introduction to Programming (3 semester hours) Computer programming in a high-level, block structured language. Basic data types and variables, memory usage, control structures, functions/procedures and parameter passing, recursion, input/output. Programming projects related to engineering applications, numerical methods. This class is designed for Electrical and Mechanical Engineering majors and cannot be used to fulfill Major Requirements for Computer Engineering, Computer Science, Software Engineering, Telecommunications Engineering majors. Prerequisite: Basic computer literacy/programming skills. (3-0) S

**CS 1335** Computer Science I for Non-majors (3 semester hours) Introduction to object-oriented software analysis, design, and development. Classes and objects. Object composition and polymorphism. Sorting and searching. Strings using core classes. Inheritance and interfaces. Graphical User Interfaces. This class cannot be used to fulfill degree requirements for majors in the School of Engineering and Computer Science. Computer Science and Engineering majors may NOT take this course. Students who have taken **CE 1337** or **CS 1337** or **TE 1337** cannot receive credit for this course. Prerequisite: **CS 1336** with a grade of C or better or equivalent. (3-0) S

**CS 1336** *(COSC 1336)* Programming Fundamentals (3 semester hours) Introduction to computers. Primitive data types, variable declarations, variable scope, and primitive operations. Control statements. Methods/functions. Arrays, and strings using primitive data arrays. Output formatting. Debugging techniques. Designed for students with no prior computer programming experience. This class cannot be used to fulfill degree requirements for majors in the School of Engineering and Computer Science. Corequisite: **CS 1136**. Note that a grade of C or better is required in order to register for **CS 1335** or **CE 1337** or **CS 1337** or **TE 1337**. (3-0) S

**CS 1337** *(COSC 1337)* Computer Science I (3 semester hours) Introduction to object-oriented software analysis, design, and development. Classes and objects. Object composition and polymorphism. Sorting, searching, recursion. Strings using core classes. Inheritance and interfaces. Graphical User Interfaces. Includes a comprehensive programming project. Prerequisite: **CS 1336** with a grade of C or better or equivalent. (Same as **CE 1337** and **TE 1337**) (3-0) S

**CS 2305** *(MATH 2305)* Discrete Mathematics for Computing I (3 semester hours) Principles of counting. Logic and proof methods, including induction. Basic recurrence relations. Basics of algorithm complexity. Sets, relations, functions. Elementary graph theory. Elementary number theory. Students cannot get credit for both **CS 2305** and (**CE 3307** or **TE 3307**). Prerequisite: **MATH 1326** or **MATH 2413** or **MATH 2417**. (Same as **CE 2305** and **TE 2305**) (3-0) S
CS 2335 Computer Science II for Non-majors (3 semester hours) Exceptions and number formatting. File input/output using Stream classes. Implementation of primitive data structures, including linked lists, stacks, queues, and binary trees. Advanced data manipulation using core classes. This class cannot be used to fulfill degree requirements for majors in the School of Engineering and Computer Science. Students who have taken CE 2336 or CS 2336 or TE 2336 cannot receive credit for this course. Prerequisite: CS 1335 or CE 1337 or CS 1337 or TE 1337. (3-0) S

CS 2336 (COSC 2336) Computer Science II (3 semester hours) Exceptions and number formatting. File input/output using Stream classes. Implementation of primitive data structures, including linked lists (all types), stacks, queues, and binary trees. Advanced data manipulation using core classes. Introduction to multi-threading, multimedia, and networking. Includes a comprehensive programming project. Prerequisite: CE 1337 or CS 1337 or TE 1337. Prerequisite or corequisite: CE 2305 or CS 2305 or TE 2305. (Same as CE 2336 and TE 2336) (3-0) S

CS 2v95 Individual Instruction in Computer Science (1-6 semester hours) Individual study under a faculty member's direction. May be repeated for credit as topics vary (6 hours maximum). Instructor consent required. (1-6-0) R

CS 3149 Competitive Learning in Computer Science (1 semester hour) In this course, students will work together in small teams to solve graduated problems, similar to those used in programming contests around the world. Approaches to categorizing problems and selecting appropriate data structures and algorithms will be covered, along with types of algorithms for solving problems (brute force, greedy, divide and conquer, dynamic programming). Students will do problem solving in a competitive environment against the clock. May be repeated for credit (3 hours maximum). Prerequisites: (CE 2336 or CS 2336 or TE 2336) and CS 3305. (1-0) Y


CS 3305 Discrete Mathematics for Computing II (3 semester hours) Advanced counting methods; recurrence relations, divide and conquer algorithms, principle of inclusion and exclusion. Partial orders and lattices, Algorithmic complexity. Graph theory. Strings and languages. Number theory. Elements of modern algebra. Students cannot receive credit for both CS 3305 and CE 3307 or TE 3307. Prerequisite: (CE 2305 or CS 2305 or TE 2305), and (MATH 2414 or MATH 2419). (3-0) S

CS 3333 Data Structures (3 semester hours) Programming with basic data structures (arrays, stacks, queues, lists, and trees) and their associated algorithms. Various sorting and searching techniques. Fundamental graph algorithms. This course covers much of the same material as CS 3345 without requiring the analysis of algorithms. Computer Science majors may NOT take this course. This course may not be taken for degree credit by students who have completed CE 2336 or CS 2336 or TE 2336. Prerequisite: CS 1335 or CE 1337 or CS 1337 or TE 1337 or CS 3335 or equivalent programming experience. (3-0) Y
CS 3335  C and C++ (3 semester hours) Numerous programming projects in both C and C++. All fundamentals of C, with special emphasis on use of pointers. Use of C++ extensions to create and extend (by inheritance) abstract data types. The use/advantages of virtual functions (dynamic polymorphism). Prerequisite: CS 2335 or CE 2336 or CS 2336 or TE 2336 or equivalent. (3-0) T

CS 3340  Computer Architecture (3 semester hours) This course introduces the concepts of computer architecture by going through multiple levels of abstraction, and the numbering systems and their basic computations. It focuses on the instruction-set architecture of the MIPS machine, including MIPS assembly programming, translation between MIPS and C, and between MIPS and machine code. General topics include performance calculation, processor datapath, pipelining, and memory hierarchy. Students who have already completed CS 2310 or equivalent cannot receive credit for this course. Students cannot receive credit for both (CS 3340 or SE 3340 or TE 3340) and (CE 4304 or EE 4304). Prerequisites: (CE 1337 or CS 1337 or TE 1337 or equivalent) and (CE 2305 or CS 2305 or TE 2305). (Same as SE 3340 and TE 3340) (3-0) S

CS 3341  Probability and Statistics in Computer Science and Software Engineering (3 semester hours) Axiomatic probability theory, independence, conditional probability. Discrete and continuous random variables, special distributions of importance to CS/SE, and expectation. Simulation of random variables and Monte Carlo methods. Central limit theorem. Basic statistical inference, parameter estimation, hypothesis testing, and linear regression. Introduction to stochastic processes. Illustrative examples and simulation exercises from queuing, reliability, and other CS/SE applications. Students cannot get credit for both (CS 3341 or SE 3341 or STAT 3341) and ENGR 3341. Prerequisites: (MATH 1326 or MATH 2414 or MATH 2419), and (CE 2305 or CS 2305 or TE 2305). (Same as SE 3341 and STAT 3341) (3-0) S

CS 3345  Data Structures and Introduction to Algorithmic Analysis (3 semester hours) Analysis of algorithms including time complexity and Big-O notation. Analysis of stacks, queues, and trees, including B-trees. Heaps, hashing, and advanced sorting techniques. Disjoint sets and graphs. Course emphasizes design and implementation. Students that completed CE 3346 or TE 3346 cannot receive credit for this course. Prerequisites: (CE 2305 or CS 2305 or TE 2305) and (CE 2336 or CS 2336 or TE 2336). Prerequisite or corequisite: CS 3341 or SE 3341 or ENGR 3341. (Same as CE 3345 and SE 3345 and TE 3345) (3-0) S

CS 3354  Software Engineering (3 semester hours) Introduction to software life cycle models. Software requirements engineering, formal specification and validation. Techniques for software design and testing. Cost estimation models. Issues in software quality assurance and software maintenance. Prerequisites: (CE 2336 or CS 2336 or TE 2336 or CS 3333), and (CE 2305 or CS 2305 or TE 2305 or equivalent). Prerequisite or corequisite: ECS 3390. (Same as CE 3354 and SE 3354) (3-0) S

CS 3360  Computer Graphics for Artists and Designers (3 semester hours) Device and logical coordinate systems, and the nature of raster display. Algorithms for basic 2-D drawing primitives, such as line-drawing, clipping and Bezier curves. Perspectives in 3-D, and hidden-face elimination, such as Painter's and Z-Buffer algorithms. Color and texture. Fractals and the Mandelbrot set. ECS majors cannot receive credit for this course. Prerequisite: CS 2335. (3-0) Y

CS 3376  C/C++ Programming in a UNIX Environment (3 semester hours) Advanced programming techniques utilizing procedural and object oriented programming in a UNIX environment. Topics include file input and output, implementation of strings, stacks, queues, lists, and trees, and dynamic memory allocation/management. Design and implementation of a comprehensive programming project is required.
Prerequisite: CE 2336 or CS 2336 or TE 2336 or equivalent. (Same as SE 3376) (3-0) S

CS 3385 Ethics, Law, Society, and Computing (3 semester hours) Issues of professional ethics; computer crime; wiretapping and encryption; protecting software and other intellectual property; privacy and information; careers and computers; reliability and safety; constitutional issues. Broader issues on the impact and control of computers. (3-0) S

CS 3v95 Undergraduate Topics in Computer Science (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 hours maximum). ([1-9]-0) S

CS 4141 Digital Systems Laboratory (1 semester hour) Laboratory to accompany CS 4341. The purpose of this laboratory is to give students an intuitive understanding of digital circuits and systems. Laboratory exercises include construction of simple digital logic circuits using prototyping kits and board-level assembly of a personal computer. Students who have already completed CS 2110 cannot receive credit for this course. Corequisite: CS 4341 or TE 4341. (Same as TE 4141) (0-2) S

CS 4314 Intelligent Systems Analysis (3 semester hours) Mathematical tools for investigating the asymptotic behavior of both deterministic and stochastic nonlinear dynamical systems for the purposes of building computational models in the fields of neuroscience, psychology, and artificial intelligence. Topics include: artificial neural network architectures, Lyapunov stability theory, nonlinear optimization theory, stochastic approximation theory, and the Gibbs Sampler. Prerequisite: CGS 4313 or instructor consent required. (Same as CGS 4314) (3-0) T

CS 4315 Intelligent Systems Design (3 semester hours) Mathematical tools for the design and evaluation of artificially intelligent deterministic and stochastic nonlinear dynamical systems for the purposes of building computational models in the fields of neuroscience, psychology, and artificial intelligence. Topics include: (1) Markov Random Field probability representations, and (2) asymptotic mathematical statistical theory for: parameter estimation, model selection, and hypothesis testing. Prerequisite: (CS 4314 or CGS 4314) or instructor consent required. (Same as CGS 4315) (3-0) T

CS 4332 Introduction to Programming Video Games (3 semester hours) Video game programming concepts. Programming with game engine. 2D and 3D computer graphics techniques and data structures. Computer animation, physics-based methods and collision detection. GPU and shader programming. Artificial intelligence for video games. Networking and multiplayer. Prerequisite: CE 3345 or CS 3345 or SE 3345 or TE 3345. (3-0) Y

CS 4334 Numerical Analysis (3 semester hours) Solution of linear equations, roots of polynomial equations, interpolation and approximation, numerical differentiation and integration, solution of ordinary differential equations, computer arithmetic, and error analysis. Students cannot receive credit for both CS 4334 and ENGR 4334. Prerequisites: (CE 1337 or CS 1337 or TE 1337) and (MATH 2418 and MATH 2451). (Same as MATH 4334) (3-0) Y

CS 4336 Advanced Java (3 semester hours) Advanced Java programming techniques integrating the technologies of advanced swing GUI components, JavaBeans, Java Servlets and Server Pages, XML, Security, Java Database Connectivity, Remote Method Invocation, and Software applications for Wireless Devices. Students will have the opportunity to work on their own E-Business Solutions. Prerequisite: CE 2336 or CS 2336 or TE 2336 or equivalent. (3-0) T
**CS 4337** Organization of Programming Languages (3 semester hours) Principles of design and implementation of contemporary programming languages. Formal description including specification of syntax and semantics of programming languages. Language definition structures including binding, scoping, data types, control structures, parameter passing, abstraction mechanism, and run-time considerations. Design issues of imperative languages, object-oriented languages, functional languages and logic languages. Design, implement, and debug programs in various programming language paradigms. Prerequisites: (CE 2336 or CS 2336 or TE 2336 or CS 3333) and (CE 2305 or CS 2305 or TE 2305) and (CS 3340 or SE 3340 or TE 3340 or CE 4304 or EE 4304). (Same as CE 4337) (3-0) S

**CS 4341** Digital Logic and Computer Design (3 semester hours) Boolean algebra and logic circuits; synchronous sequential circuits; gate level design of ALSU, registers, and memory unit; register transfer operations; design of data path and control unit for a small computer; Input-Output interface. Students cannot receive credit for both (CS 4341 or TE 4341) and (CE 3320 or EE 3320). Prerequisites: (CE 2310 or EE 2310) or (CS 3340 or SE 3340 or TE 3340) and PHYS 2326. Corequisite: (CS 4141 or TE 4141). (Same as TE 43 41) (3-0) S

**CS 4347** Database Systems (3 semester hours) This course emphasizes the concepts and structures necessary for the design and implementation of database management systems. Topics include data models, data normalization, data description languages, query facilities, file organization, index organization, file security, data integrity, and reliability. Prerequisite: CE 3345 or CS 3345 or SE 3345 or TE 3 345. (Same as SE 4347) (3-0) Y

**CS 4348** Operating Systems Concepts (3 semester hours) An introduction to fundamental concepts in operating systems: their design, implementation, and usage. Topics include process management, main memory management, virtual memory, I/O and device drivers, file systems, secondary storage management, and an introduction to critical sections and deadlocks. Prerequisites: (CS 3340 or SE 3340 or TE 3340 or equivalent), and (CE 3345 or CS 3345 or SE 3345 or TE 3345), and a working knowledge of C and UNIX. (Same as CE 4348 and SE 4348 and TE 4348) (3-0) S

**CS 4349** Advanced Algorithm Design and Analysis (3 semester hours) Asymptotic analysis, recurrences, and graph algorithms. Algorithm design techniques such as greedy method, dynamic programming, and divide-and-conquer. Issues from computational complexity. Course emphasizes a theoretical approach. Prerequisites: CS 3305, and (CE 3345 or CS 3345 or SE 3345 or TE 3345). (3-0) S

**CS 4352** Human Computer Interactions I (3 semester hours) Methods and principles of human-computer interaction (HCI), user-centered design (UCD), and usability evaluation. Provides broad overview of HCI and how HCI informs UCD processes throughout product development lifecycle. (Same as C 4352) (3-0) T

**CS 4353** Human Computer Interactions II (3 semester hours) Detailed exploration of human-computer interaction (HCI) through readings in journal articles and research reports. Practical experience in methodology typically used in the design of usable systems. Prerequisite: (CS 4352 or C 4352) or instructor consent required. (Same as C 4353) (3-0) T

**CS 4361** Computer Graphics (3 semester hours) Review of graphic display architecture and graphic input devices. Two- and three-dimensional transformations, matrix formulations, and concatenation. Clipping and windowing. Data structures for graphics systems, segmented display files, rings, etc. Hidden line and surface elimination. Shading. Graphics packages and applications. Prerequisites: MATH 2418, and (CE 2336
or **CS 2336** or **TE 2336**), and (**CE 3345** or **CS 3345** or **SE 3345** or **TE 3345** or equivalent). (3-0) Y

**CS 4365** Artificial Intelligence (3 semester hours) Basic concepts and techniques that enable computers to perform intelligent tasks. Examples are taken from areas such as natural language understanding, computer vision, machine learning, search strategies and control, logic, and theorem proving. Prerequisite: **CE 3345** or **CS 3345** or **SE 3345** or **TE 3345** or equivalent. (3-0) Y

**CS 4375** Introduction to Machine Learning (3 semester hours) Algorithms for creating computer programs that can improve their performance through learning. Topics include: cross-validation, decision trees, neural nets, statistical tests, Bayesian learning, computational learning theory, instance-based learning, reinforcement learning, bagging, boosting, support vector machines, Hidden Markov Models, clustering, and semi-supervised and unsupervised learning techniques. Prerequisites: (**CS 3341** or **SE 3341**) and (**CE 3345** or **CS 3345** or **SE 3345** or **TE 3345** or equivalent). (3-0) Y

**CS 4376** Object-Oriented Programming Systems (3 semester hours) In-depth study of the features/advantages of object-oriented approach to problem solving. Special emphasis on issues of object-oriented analysis, design, implementation, and testing. Review of basic concepts of object-oriented technology (abstraction, inheritance, and polymorphism). Object-oriented programming languages, databases, and productivity tools. Prerequisite: **CE 2336** or **CS 2336** or **TE 2336** or equivalent. (Same as **SE 4376**) (3-0) S

**CS 4384** Automata Theory (3 semester hours) A review of the abstract notions encountered in machine computation. Topics include finite automata, regular expressions, PDAs, and context-free languages. Prerequisite: **CS 3305**. (3-0) S

**CS 4386** Compiler Design (3 semester hours) Basic phases of a compiler and their design principles. Topics include lexical analysis, basic parsing techniques such as LR(K) and LL(K) grammars. Prerequisite: **CE 3345** or **CS 3345** or **SE 3345** or **TE 3345** (or equivalent). (3-0) R

**CS 4389** Data and Applications Security (3 semester hours) Data as a critical resource. Threats to data and applications security including access control violations, integrity violations, unauthorized intrusions and sabotage; techniques to enforce security. Prerequisite: **CS 4347** or **SE 4347**. (3-0) Y

**CS 4390** Computer Networks (3 semester hours) The design and analysis of computer networks. Topics include the ISO reference model, transmission media, medium-access protocols, LANs, data link protocols, routing, congestion control, internetworking, and connection management. Students cannot get credit for both (**CE 4390** or **CS 4390** or **TE 4390**) and **EE 4390**. Prerequisite: **CE 3345** or **CS 3345** or **SE 3345** or **TE 3345** or equivalent. (Same as **CE 4390** and **TE 4390**) (3-0) S

**CS 4391** Introduction to Computer Vision (3 semester hours) Techniques for manipulating and extracting information from digital images and video. Topics include color representations, analysis and processing based on image histograms, geometric transformations, convolutions, image blurring and sharpening, extraction of edges, matching, image and video motion. Prerequisites: **CE 3345** or **CS 3345** or **SE 3345** or **TE 3345** or equivalent. (3-0) Y

**CS 4392** Computer Animation (3 semester hours) Introduction to traditional animation. Kinematics of motion. Key framing. Coordinate systems and transformations (review), Euler angles and Quaternions, Catmull Rom and B-Splines, Advanced Key framing, articulated figures (forward kinematics), human and animal modeling (soft tissue, skin, etc.). Facial animation (parametric). Physically based modeling (rigid,
collision detection). Physically based modeling (deformable). Behavioral and heuristic models. Algorithmic animation. Optimization techniques. Animation languages and systems. Motion capture and real time control. Virtual reality and animation. Rendering and temporal aliasing. 2D and 3D morphing. 3D modeling. Prerequisites: MATH 2418 and (CE 3345 or CS 3345 or SE 3345 or TE 3345 or equivalent). (3-0) Y

CS 4393 Computer and Network Security (3 semester hours) The study of security and vulnerabilities in computer and network systems. Common attacking techniques such as buffer overflow, viruses, worms, etc. Security in existing systems such as UNIX, Windows, and JVM. Fundamental access control and information flow concepts. Symmetric Ciphers such as DES and AES. Public-key encryption techniques and related number theory. Message authentication, hash functions, and digital signatures. Authentication applications, IP security and Web security. Prerequisite: CE 4348 or CS 4348 or SE 4348 or TE 4348 or equivalent. (3-0) Y

CS 4394 Implementation of Modern Operating Systems (3 semester hours) This course focuses on developing systems implementation skills through a set of projects. Each project will explore one fundamental component of operating systems such as process scheduling, memory management, device drivers, file systems, and network communication management. The projects are expected to involve kernel-level programming. Prerequisites: (CE 4348 or CS 4348 or SE 4348 or TE 4348) and CS 3335, or equivalent programming experience. (3-0) R

CS 4395 Human Language Technologies (3 semester hours) Introduction to human language technologies (HLT), the study of natural languages from a computational perspective. Topics include computational models of syntax and semantics, natural language applications (such as machine translation, speech processing, information retrieval, and information extraction), and general machine-learning techniques commonly used in state-of-the-art HLT research. Prerequisite: (CS 3341 or SE 3341, and (CE 3345 or CS 3345 or SE 3345 or TE 3345 or equivalent). (3-0) Y

CS 4396 Networking Laboratory (3 semester hours) This course takes a lab-oriented approach to demonstrate how basic networking concepts are applied in a real network. The hands-on projects include setting up simple network topologies, configuring devices to run basic network protocols, and using various debugging tools to identify, locate, and fix common problems in networking. Pre- or corequisite: CS 4390 or equivalent. (3-0) Y

CS 4397 Embedded Computer Systems (3 semester hours) Introduction to embedded computer applications and concepts. Real-time operating systems and resource management. Real-time scheduling and communication. Senior data acquisition, processing and fusion. Error handling, fault tolerance, and graceful degradation. System performance analysis and optimization techniques. Includes a project to develop and analyze a small embedded computer application. Prerequisite: CE 4348 or CS 4348 or SE 4348 or TE 4348 or equivalent. (3-0) Y

CS 4398 Digital Forensics (3 semester hours) Creating and preserving digital evidence, data recovery and evidence collection algorithms, evidence construction and reconstruction, methods for certifying evidence, storing evidence, data acquisition, forensic analysis algorithms, image files, network forensics, logging methods to trace back attacks and digital trails, e-mail investigations. Prerequisites: (CE 4348 or CS 4348 or SE 4348 or TE 4348) and (CE 4390 or CS 4390 or TE 4390) or equivalent. (3-0) Y

CS 4399 Senior Honors in Computer Science (3 semester hours) For students conducting independent
research for honors theses or projects. Topics may vary. (3-0) R

**CS 4485** Computer Science Project (4 semester hours) This course is intended to complement theory and to provide an in-depth, hands-on experience in all aspects of a software development project. Students will work in teams on projects of interest to industry and will be involved in specifying the problem and its solution, designing and analyzing the solution, developing the software architecture, along with implementation and testing plans. The deliverables will include reports that document these steps as well as a final project report, including the challenges they faced, and a user manual of the developed system. Students will explore security issues of their project and its potential impact on society. Teams will also make presentations as well as demonstrate their software. Additionally, this course will cover topics related to computer science profession including ethics and professional responsibility, entrepreneurship, leadership, and project management. Prerequisites: (CE 3345 or CS 3345 or SE 3345 or TE 3345), and (CE 3354 or CS 3354 or SE 3354 or equivalent), and at least three CS 43XX classes. (4-0) S

**CS 4v95** Undergraduate Topics in Computer Science (1-9 semester hours) Subject matter will vary from semester to semester. May be used as CS Guided Elective on CS degree plans. May be repeated for credit as topics vary (9 hours maximum). ([1-9]-0) R

**CS 4v98** Undergraduate Research in Computer Science (1-9 semester hours) Topics will vary from semester to semester. May be repeated for credit as topics vary (9 hours maximum). Instructor consent required. ([1-9]-0) R

## Engineering and Computer Science

**ECS 1200** Introduction to Engineering and Computer Science (2 semester hours) Introduction to the engineering and computing professions, professional ethics. Overview of ECS curricula, connections among ECS fields and to the sciences, and other fields. Basic study, problem solving and other skills needed to succeed as an ECS major. Engineering design and quantitative methods. Multi-disciplinary team projects designed to replicate decision processes in real-world situations. (1-2) Y

**ECS 3301** Introduction to Nanoscience and Nanotechnology (3 semester hours) Introduction to the underlying principles and applications of the emerging field of nanotechnology and nanoscience. Intended for a multidisciplinary audience with a variety of backgrounds. Introduces tools and principles relevant at the nanoscale dimension. Discusses current and future nanotechnology applications in engineering, materials, physics, chemistry, biology, electronics, and energy. Prerequisites: CHEM 1311, MATH 2419 or MATH 2415, PHYS 2326 or instructor consent required. (Same as NANO 3301) (3-0) Y

**ECS 3310** Introduction to Materials Science (3 semester hours) This course provides an intensive overview of materials science and engineering focusing on how structure/property/processing relationships are developed and used for different types of materials. The course illustrates roles of materials in modern technology by case studies of advances in new materials and process. Topics include atomic structure, crystalline solids, defects, failure mechanisms, phase diagrams and transformations, metal alloys, ceramics, polymers as well as their mechanical, thermal, electrical, magnetic and optical properties. Prerequisites: CHEM 1311, MATH 2419 or MATH 2415, PHYS 2326 or instructor consent required. (Same as NANO 3310) (3-0) Y
**ECS 3361** Social Issues and Ethics in Computer Science and Engineering (3 semester hours) This course exposes students to major theoretical approaches and modes of reasoning about ethics while exploring a range of important professional and ethical issues in computing and engineering, and the interrelationship between the computing and engineering professions and important elements of social systems. Issues of professional ethics, computer crime and privacy, intellectual property, the balance between the acceptability of risk and constraints such as cost, scheduling, safety and quality, the role of globalization and various important constitutional issues are explored by drawing upon engineering and computing case studies. (Same as **SOCS 3361**) (3-0) Y

**ECS 3390** Professional and Technical Communication (3 semester hours) Expands students' professional and team communication skills and strategies in technical contexts. Integrates writing, speaking and group communication by developing and presenting technical information to different audiences. Written assignments focus on creating professional technical documents, such as proposals, memos, abstracts, reports and letters. Presentation assignments emphasize planning, preparing and delivering dynamic, informative and persuasive presentations. Attendance at first class mandatory. Prerequisites: **RHET 1302** and junior standing. (3-0) S

**Engineering and Computer Science COOP**

**ECSC 3177** CS IPP Assignment (1 semester hour) Work in an approved, supervised, professional, computer science position. Students will complete an IPP Work Report including a written narrative focusing on the accomplishments and learning gained through the IPP experience. May be repeated. (1-0) Y

**ECSC 3179** ENG IPP Assignment (1 semester hour) Work in an approved, supervised, professional, engineering position. Students will complete an IPP Work Report including a written narrative focusing on the accomplishments and learning gained through the IPP experience. May be repeated. (1-0) Y

**ECSC 4300** Student Apprenticeship and Mentoring (3 semester hours) Development and practice of teaching and mentoring skills in engineering and computer science. May be repeated for credit (6 hours maximum). Prerequisite: instructor consent required. (3-0) S

**ECSC 4378** Professional Industrial Practice Program (3 semester hours) Students will make use of professional engineering/computer science skills within an industrial setting as part of co-op/intern work experience. Detailed midterm and final professional quality engineering reports on the co-op project are required. Topics may vary. May be repeated for credit (6 hours maximum). Pre- or corequisite: **ECS 3390**. (3-0) T

**Electrical Engineering**

**EE 1202** Introduction to Electrical Engineering (2 semester hours) **EE 1202** introduces the discipline of engineering. It includes a 1.5-hour lecture per week plus a 3-hour fundamentals laboratory that stresses learning about laboratory procedures and equipment. Topics include: Learning the use of common laboratory electronic equipment; understanding the assembly of electronic circuits; and making various measurements. Students also learn how to work together with a partner and how to write a laboratory report. The lecture introduces general engineering practices, engineering research at UTD, engineering
activities at selected local companies, and concepts such as innovation and invention. The course also includes lectures and projects on communication, understanding the importance of lifelong learning, ethics, and a knowledge of contemporary issues. EE 1202 may be taken by students outside of engineering in order to learn about the engineering profession. (Same as CE 1202 and TE 1202) (1.5-3) S

EE 2310 Introduction to Digital Systems (3 semester hours) Introduction to digital circuits, hardware structures, and assembly-language concepts that underlie the design of modern computer systems. Topics include: Internal data representation and arithmetic operations in a computer, basic logic circuits, MIPS assembly language and an overview of computer architecture. Some knowledge of a high-level language such as C++ or Java is expected. This class also has a laboratory component. Exercises will be assigned in class for completion in the laboratory. This class may be offered as either regular or honors sections (H). (Same as CE 2310) (3-1) S

EE 2v99 Topics in Electrical Engineering (1-4 semester hours) May be repeated as topics vary (9 hours maximum). ([1-4]-0) R

EE 3101 Electrical Network Analysis Laboratory (1 semester hour) Laboratory to accompany EE 3301. Design, assembly and testing of linear electrical networks and systems. Use of computers to control electrical equipment and acquire data. Prerequisites: (CE 1202 or EE 1202 or TE 1202) and RHET 1302. Corequisite: EE 3301. (Same as CE 3101 and TE 3101) (0-1) S

EE 3102 Signals and Systems Laboratory (1 semester hour) Laboratory based on MATLAB and LabVIEW to provide implementation experience on topics covered in EE 3302. Laboratory experiments cover linear time-invariant systems, convolution, Fourier series, continuous Fourier transform, sampling, discrete Fourier transform, analog and digital filtering. Each lab is followed by a design application. Corequisite: EE 3302. Prerequisite: RHET 1302. (Same as CE 3102 and TE 3102) (0-1) S

EE 3110 Electronic Devices Laboratory (1 semester hour) Laboratory to accompany EE 3310. Experimental determination and illustration of properties of carriers in semiconductors including carrier drift, carrier diffusion; p-n junctions including forward and reverse bias effects and transient effects; bipolar transistors including the Ebers-Moll model and secondary effects; field effect transistors including biasing effects, MOS capacitance and threshold voltage. Corequisite: CE 3310 or EE 3310. Prerequisite: RHET 1302. (Same as CE 3110) (0-1) S

EE 3111 Electronic Circuits Laboratory (1 semester hour) Laboratory to accompany EE 3311. Design, assembly and testing of electronic circuits that use diodes, transistors and operational amplifiers in configurations typically encountered in practical applications. Corequisite: CE 3311 or EE 3311. Prerequisite: RHET 1302. (Same as CE 3111) (0-1) S

EE 3120 Digital Circuits Laboratory (1 semester hour) Laboratory to accompany EE 3320. Design, assembly, and testing of logic circuits. Use of programmable logic devices and simple CAD tools. Corequisite: CE 3320 or EE 3320. Prerequisite: RHET 1302. (Same as CE 3120) (0-1) S

EE 3150 Communications Systems Laboratory (1 semester hour) Laboratory to accompany EE 3350. Fundamental elements of communications systems hardware; use of spectrum analyzers and other measurement instruments typically encountered in communication systems; design of active filters in communications systems; analog frequency and amplitude modulators and demodulators; data communication systems. Corequisite: EE 3350. Prerequisite: (CE 3301 or EE 3301 or TE 3301) and RHET 130
2. (Same as **TE 3150**) (0-1) S

**EE 3301** Electrical Network Analysis (3 semester hours) Analysis and design of RC, RL, and RLC electrical networks. Sinusoidal steady state analysis of passive networks using phasor representation; mesh and nodal analyses. Introduction to the concept of impulse response and frequency analysis using the Laplace transform. Prerequisites: **MATH 2420** and **PHYS 2326**. Corequisite: **EE 3101**. (Same as **CE 3301** and **TE 3301**) (3-0) S

**EE 3302** Signals and Systems (3 semester hours) Introduces the fundamentals of continuous and discrete-time signal processing. Linear system analysis including convolution and impulse response, Fourier series, Fourier transform and applications, discrete-time signal analysis, sampling and z-transform. Prerequisite: **ENGR 3300**. Corequisite: **EE 3102**. (Same as **CE 3302** and **TE 3302**) (3-0) S

**EE 3310** Electronic Devices (3 semester hours) Theory and application of solid state electronic devices. Physical principles of carrier motion in semiconductors leading to operating principles and circuit models for diodes, bipolar transistors, and field effect transistors. Introduction to integrated circuits. Prerequisite: **CE 3301** or **EE 3301** or **TE 3301**. Corequisite: **CE 3110** or **EE 3110**. (Same as **CE 3310**) (3-0) S

**EE 3311** Electronic Circuits (3 semester hours) Large-signal and small-signal characteristics of diodes, BJT and MOSFET transistors. Analysis of circuits containing diodes. Analysis of the DC and small-signal characteristics of single-stage BJT and MOSFET amplifiers. Analysis of circuits with an operational amplifier as a black box. Introduction of high-frequency models of BJT and MOSFET transistors and methods to analyze amplifier frequency response. Prerequisite: **CE 3310** or **EE 3310**. Corequisite: **CE 3111** or **EE 3111**. (Same as **CE 3311**) (3-0) S

**EE 3320** Digital Circuits (3 semester hours) Design and analysis of combinational logic circuits using basic logic gates and other building blocks like multiplexers and ROMs. Design and analysis of latches and flip-flops. Design and analysis of synchronous state machines. State minimization and introduction to state assignment. Design of datapath components: adders, multipliers, registers, shifters, and counters. Electrical properties of logic gates. Students cannot receive credit for both **CS 4341** and **CE 3320** or **EE 3320**. Prerequisite: **CE 2310** or **EE 2310**. Corequisite: **EE 3120**. (Same as **CE 3320**) (3-0) S

**EE 3350** Communications Systems (3 semester hours) Fundamentals of communications systems. Review of probability theory and Fourier transforms. Filtering and noise. Modulation and demodulation techniques, including amplitude, phase, and pulse code. Time division multiplexing. This class may be offered as either regular or honors sections (H). Prerequisites: **ENGR 3300** and (**CE 3301** or **EE 3301** or **TE 3301**) and (**CE 3302** or **EE 3302** or **TE 3302**) and **ENGR 3341**. Corequisite: **EE 3150** or **TE 3150**. (Same as **TE 3350**) (3-0) S

**EE 4168** RF/Microwave Laboratory (1 semester hour) This course provides hands-on learning of RF and microwave fundamentals in a laboratory setting. The weekly lab sessions are designed, both in subject material and timeframe, to compliment the theory taught in **EE 4368**. The goal of this laboratory is to enable students to become familiar with RF test equipment, measurement techniques and design procedures. The second half of this lab involves design of microwave transmission media (primarily microstrip), impedance matching circuits and characterization of microwave transistors, culminating in the complete design, fabrication and test of a single-stage microwave amplifier. Pre- or corequisite: **EE 4368**. (0-1) Y
EE 4301 Electromagnetic Engineering I (3 semester hours) Introduction to the general characteristics of wave propagation. Physical interpretation of Maxwell's equations. Propagation of plane electromagnetic waves and energy. Transmission lines. Antenna fundamentals. Prerequisites: PHYS 2326 and ENGR 3300 and (CE 3301 or EE 3301 or TE 3301). (3-0) S

EE 4302 Electromagnetic Engineering II (3 semester hours) Continuation of the study of electromagnetic wave propagation. Metallic and dielectrically guided waves including microwave waveguides and optical fibers. Dipole antennas and arrays. Radiating and receiving systems, plasmas. Propagation of electromagnetic waves in materials and material properties. This course may be used as an honors course. Prerequisite: EE 4301. (3-0) S

EE 4304 Computer Architecture (3 semester hours) Introduction to computer organization and design, including the following topics: CPU performance analysis. Instruction set design, illustrated by the MIPS instruction set architecture. Systems-level view of computer arithmetic. Design of the datapath and control for a simple processor. Pipelining. Hierarchical memory. I/O systems. I/O performance analysis. Multiprocessing. Students cannot receive credit for both (CS 3340 or SE 3340 or TE 3340) and (EE 4304 or EE 4304). Prerequisite: CE 3320 or EE 3320. (Same as CE 4304) (3-0) S

EE 4310 Systems and Controls (3 semester hours) Introduction to linear control theory. General structure of control systems. Mathematical models including differential equations, transfer functions, and state space. Control system characteristics. Transient response, external disturbance, and steady-state error. Control system analysis. Performance, stability, root-locus method, Bode diagram, and Nyquist plot. Control system design. Compensation design using phase-lead and phase-lag networks. Prerequisites: ENGR 2300, and (CE 3302 or EE 3302 or TE 3302). (3-0) S

EE 4325 Introduction to VLSI Design (3 semester hours) Introduction to CMOS digital IC design using semi-custom and full-custom design techniques with an emphasis on techniques for rapid prototyping and use of various VLSI design tools. FPGA's, standard cell and full-custom design styles. Introduction to a wide variety of CAD tools. Prerequisite: CE 3320 or EE 3320 (or, for CS majors, CS 4341). (3-0) T

EE 4330 Integrated Circuit Technology (3 semester hours) Principles of design and fabrication of integrated circuits. Bipolar and MOS technologies. Passive and active component performance, fabrication techniques including epitaxial growth, photolithography, oxidation, diffusion, ion-implantation, thin and thick film components. Design and layout of integrated devices. Relations between layout and fabrication technique. Prerequisite: CE 3320 or EE 3320. (3-0) T

EE 4340 Analog Integrated Circuit Analysis and Design (3 semester hours) Analog integrated circuits and systems. Analysis and design of linear amplifiers, including operational, high-frequency, broad-band and feedback amplifiers. Use of monolithic silicon systems. Prerequisite: CE 3311 or EE 3311. (3-0) T

EE 4341 Digital Integrated Circuit Analysis and Design (3 semester hours) Digital integrated circuits. Large signal model for bipolar and MOS transistors. MOS inverters and gates. Propagation delay and noise margin. Dynamic logic concepts. Bipolar transistor inverters and gates, regenerative logic circuits, memories. Prerequisites: (CE 3311 or EE 3311), and (CE 3320 or EE 3320). (3-0) T

EE 4360 Digital Communications (3 semester hours) Information, digital transmission, channel capacity, delta modulation, and differential pulse code modulation are discussed. Principles of coding and digital modulation techniques such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift
Keying (PSK), and Continuous Phase Frequency Shift Keying (CPFSK) are introduced. M-ary signaling such as Quadrature amplitude and phase shift keying, and M-ary PSK and FSK are also discussed. Prerequisite: EE 3350 or TE 3350. (Same as TE 4360) (3-0) T

EE 4361 Introduction to Digital Signal Processing (3 semester hours) An introduction to the analysis and design of discrete linear systems, and to the processing of digital signals. Topics include time and frequency domain approaches to discrete signals and systems, the Discrete Fourier Transform and its computation, and the design of digital filters. Prerequisite: CE 3302 or EE 3302 or TE 3302. (Same as TE 436 1) (3-0) T

EE 4365 Introduction to Wireless Communication (3 semester hours) Introduction to the basic system concepts of cellular telephony. Mobile standards, mobile system architecture, design, performance and operation. Voice digitization and modulation techniques; PCS technologies. Prerequisite: EE 3350 or TE 335 0. (Same as TE 4365) (3-0) Y

EE 4367 Telecommunication Networks (3 semester hours) Trunking and queuing, switching technologies: voice, data, video, circuit switching and packet switching, transmission technologies and protocols, transmission media - copper, fiber, microwave, satellite, protocols - bipolar formats, digital hierarchy, optical hierarchy, synchronization, advanced switching protocols and architectures; frame relay, ATM, HDTV, SONET. Prerequisite or Corequisite: EE 3350 or TE 3350. (Same as TE 4367) (3-0) Y

EE 4368 RF Circuit Design Principles (3 semester hours) Principles of high-frequency design, transmission lines, the Smith chart, impedance matching using both lumped and distributed components, and simple amplifier design. Prerequisites: (CE 3310 or EE 3310) and EE 4301. (3-0) Y

EE 4388 Senior Design Project I (3 semester hours) First of two sequential semesters devoted to a team project that engages students in the full engineering design process. The goal of senior design projects is to prepare the student to run/participate in engineering projects related to an appropriate industry. Thus, all project teams are to follow standard industrial practices and methods. Teams must carry the engineering project to completion, examining real world and multiple design constraints, following applicable industrial and business standards. Such constraints may include but are not limited to: economic, environmental, industrial standards, team time/resource management and cross-disciplinary/departamental result integration. Students are required to work in teams that include collaborative design interaction. Additionally, cross-disciplinary teams are encouraged but not required. In Senior Design I, project proposals will be written, reviewed and approved. Initial designs will be completed and corresponding constraints will be determined. All students will participate in a public oral and poster presentation following departmental approved guidelines at a departmental approved time and location. Teams will also submit a written end of semester progress report and documented team communication (complete sets of weekly reports and/or log books) following guidelines approved by the faculty. Students must have completed ECS 3390 and one of the following prerequisite sequences: (CE 3311 or EE 3311), and (CE 3320 or EE 3320), and (CE 3345 or CS 3345 or SE 3345 or TE 3345), and (CE 3354 or CS 3354 or SE 3 354), or (ENGR 3300 and (CE 3302 or EE 3302 or TE 3302), and (CE 3311 or EE 3311), and (CE 3320 or EE 3 320), or (ENGR 3300 and (CE 3302 or EE 3302 or TE 3302), and (CE 3345 or CS 3345 or SE 3345 or TE 334 5); prerequisite or corequisite: EE 3350 or TE 3350.) (Same as CE 4388 and TE 4388) (3-0) S

EE 4389 Senior Design Project II (3 semester hours) Continuation of the Senior Design project begun in the previous semester. In Senior Design II, projects based on approved project proposals will be completed. All
limitations of the design will be determined and addressed. All students will participate in a public oral presentation following faculty-approved guidelines at a faculty-approved time and location. Teams will also submit a written final report and documented team communication (complete sets of weekly reports and/or log books) following faculty-approved guidelines. Prerequisite: CE 4388 or EE 4388 or TE 4388. (Same as CE 4389 and TE 4389) (3-0) S

EE 4390 Computer Networks (3 semester hours) An introduction to packet-based computer and data communication networks, including the OSI model, Internet, TCP/IP, ATM, Ethernet, Frame Relay, and Local Area Networks. Enterprise network design procedures are introduced in conjunction with IP routing, VPN, MPLS and VOIP. Students cannot receive credit for both (CE 4390 or CS 4390 or TE 4390) and EE 4390. Prerequisite or Corequisite: EE 3350 or TE 3350. (3-0) S

EE 4391 Technology of Plasma (3 semester hours) Plasmas are critical to making the best electronic devices. This class will be an introduction to the technology required to make and use these plasmas. Topics include: high-vacuum technology (gas properties, pumps, pressure gauges, flow-meters, gas composition analysis) and plasma technology (etch, deposition, and lamps). Prerequisites: ENGR 3300 and (CE 3310 or EE 3310). Recommended: ENGR 3341. (Same as NANO 4391) (3-0) Y

EE 4392 Introduction to Optical Systems (3 semester hours) Operating principles of optical communications systems and fiber optic communication technology. Lightwave fundamentals, characteristics of integrated optic waveguides and optical fibers, attenuation and dispersion, operating principles of optical sources, detectors and optical amplifiers, optical transmitters and receivers, modulation techniques, effect of noise in optical systems, system design fundamentals, network topologies. Prerequisites: (CE 3302 or EE 3302 or TE 3302), and EE 4301 and (CE 3310 or EE 3310). (3-0) T

EE 4399 Senior Honors in Electrical Engineering (3 semester hours) For students conducting independent research for honors theses or projects. This course may be used as an honors course. May be repeated for credit as topics vary. (3-0) R

EE 4v95 Undergraduate Topics in Electrical Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 hours maximum). [[1-9]-0] R

EE 4v97 Independent Study in Electrical Engineering (1-9 semester hours) Independent study under a faculty member's direction. May be repeated for credit as topics vary (9 hours maximum). Instructor consent required. [[1-9]-0] R

EE 4v98 Undergraduate Research in Electrical Engineering (1-9 semester hours) May be repeated for credit as topics vary (9 hours maximum). This course may be used as an honors course. [[1-9]-0] R

**Engineering**

ENGR 2300 Linear Algebra for Engineers (3 semester hours) Matrices, vectors, linear systems of equations, Gauss-Jordan elimination, LU factorization and rank. Vector spaces, linear dependence/independence, basis, and change of basis. Linear transformations and matrix representation; similarity, scalar products, orthogonality, Gram-Schmidt procedures, and QR factorization. Determinants: eigenvalues, eigenvectors, and diagonalization. Introduction to problem solving using MATLAB. This course includes a required laboratory. Students cannot get credit for both ENGR 2300 and MATH 2418. Pre- or corequisite: MATH 241
ENGR 3300 Advanced Engineering Mathematics (3 semester hours) Survey of advanced mathematics topics needed in the study of engineering. Topics include review of complex numbers, multivariate calculus and analytic geometry. Study of polar, cylindrical, and spherical coordinates, vector differential calculus, vector integral calculus, and vector integral theorems. Examples are provided from electromagnetic, fluid mechanics, physics and geometry. Prerequisite: MATH 2415 or MATH 2419. (3-0) S

ENGR 3341 Probability Theory and Statistics (3 semester hours) Axioms of probability, conditional probability, Bayes theorem, random variables, probability density/mass function (pdf/pmf), cumulative distribution function, expected value, functions of random variables, joint, conditional and marginal pdfs/pmf for multiple random variables, moments, central limit theorem, elementary statistics, empirical distribution correlation. Students cannot get credit for both (CS 3341 or SE 3341 or STAT 3341) and ENGR 3341. Prerequisite: MATH 2414 or MATH 2419. Recommended co-requisite: MATH 2420. (3-0) S

ENGR 4334 Numerical Methods in Engineering (3 semester hours) Computer arithmetic and error analysis. Solution of linear equations, roots of polynomial equations, interpolation and approximation, numerical differentiation and integration, solution of ordinary differential equations. Emphasis on engineering applications and numerical software. Students cannot get credit for both (CS 4334 or MATH 4334) and ENGR 4334. Prerequisites: ENGR 2300 and ENGR 3300 and knowledge of a high level programming language. (3-0) Y

ENGR 4343 Engineering Economy (3 semester hours) The objective of this course is to introduce undergraduate students to economic evaluation and analysis of engineering projects and proposals. Economic tools are essential for planning and design of engineering systems in today's ever-changing high-tech world. This course will also prepare the electrical engineering students for the "Engineering Economy" portion of the Fundamentals of Engineering Exam required for the professional engineer's license. Prerequisites: MATH 2413 or MATH 2417 and upper-division standing. (3-0) T

Interdisciplinary Studies-EE and CS

ISEC 4102 Computer Art Laboratory (1 semester hour) This course involves the creation and use of algorithms for art on microcomputers. Will not satisfy core requirement in Natural Sciences. Corequisite: ISEC 4201. (0-2) R

ISEC 4201 (2 semester hours) This course explores the problems, tools, and opportunities presented to the artist by the birth of this new medium. From the analytic aspects of computer graphics to the aesthetics of interactive design, the wide range of extant techniques foreshadows the richness of future computer art. Will not satisfy core requirement in Natural Sciences. Corequisite: ISEC 4102. (2-0) R


ISEC 4v87 Special Interdisciplinary Topics in Engineering or Computer Science (1-6 semester hours) Subject...
Mechanical Engineering

**MECH 1208** Introduction to Mechanical Engineering (2 semester hours) The purpose of this course is to give students a general understanding of the broad range of technical areas and applications specific to the mechanical engineering profession. Course activities include team-oriented competitions, and lectures by mechanical engineering experts. Prerequisite: ECS 1200. Prerequisites or corequisites: PHYS 2325 and PHYS 2125 and (MATH 2419 or MATH 2414). (1-1) Y

**MECH 1v95** Topics in Mechanical Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated as topics vary (9 hours maximum). (1-9) Y

**MECH 2120** Mechanical Measurements Laboratory (1 semester hour) Laboratory course. The laboratory introduces mechanical measurement techniques and processes. Introduction to basic instrumentation used in mechanical engineering, including calibration, use, precision, and accuracy. Consideration of errors, precision, and accuracy in experimental measurements. Corequisite: MECH 2320. (0-1) Y

**MECH 2310** Statics (3 semester hours) Lecture course. Course material includes vector representations of forces and moments, free body diagrams, equilibrium of particles, center of mass, centroids, distributed load systems, equivalent force systems, equilibrium of rigid bodies, trusses, frames and machines, internal forces in structural members, shear forces and bending moments in beams, friction, area and mass moments of inertia, the principle of virtual work. Prerequisites: MECH 1208 and (PHYS 2325 and PHYS 2125). Prerequisite or corequisite: MATH 2419. (3-0) Y

**MECH 2320** Strength of Materials (3 semester hours) Lecture course. Introduction to stress and deformation analysis of basic structural elements subjected to axial, torsional, bending, and pressure loads. Prerequisites: (MATH 2419 or MATH 2415) and MECH 2310. Corequisite: MECH 2120. (3-0) Y

**MECH 2330** Dynamics (3 semester hours) Lecture course. Kinematics and kinetics of particles, planar rigid bodies, three-dimensional rigid bodies and equations of motion. Methods utilizing force and acceleration, work and energy and impulse and momentum. Single degree of freedom vibration systems are and simulation tools are introduced. Prerequisites: MECH 2310. Prerequisite or corequisite: ENGR 2300 and MA TH 2420. (3-0) Y

**MECH 2v95** Topics in Mechanical Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated as topics vary (9 hours maximum). (1-9) Y

**MECH 3105** Computer Aided Design Laboratory (1 semester hour) Project-based course associated with MECH 3305. Design projects involving CAD tools constitute a major portion of the course. Corequisite: MECH 3305. (0-1) Y

**MECH 3115** Fluid Mechanics Laboratory (1 semester hour) Laboratory course associated with MECH 3315. Wind tunnel calibration and survey, wind tunnel turbulence tests, boundary layer on a flat plate, static stability, design and conduct experiments. Prerequisite: MECH 3315; it is recommended that the laboratory is taken the next long semester after completion of MECH 3315. (0-1) Y
MECH 3120  Heat Transfer Laboratory (1 semester hour) Laboratory course associated with MECH 3320. Course emphasis is on experiments related to thermodynamics, heat transfer, and fluid mechanics. Proper experimental methods, data and uncertainty analysis related to thermal and fluids measurements are discussed. Prerequisite: MECH 3320; it is recommended that the laboratory is taken the next long semester after completion of MECH 3320. (0-1) Y

MECH 3150  Kinematics and Dynamics Laboratory (1 semester hour) Project-based course associated with MECH 3350. Laboratory course focused on performing a team design project of a mechanical system. Prerequisite: MECH 3350; it is recommended that the laboratory is taken the next long semester after completion of MECH 3350. (0-1) Y

MECH 3301  Mechanics of Materials (3 semester hours) Lecture course. Course material includes determination of stresses, deflections, and stability of deformable bodies, including theory of advanced beams, elasticity and matrix structural analysis. Prerequisites: MECH 2320 and ENGR 3300. (3-0) Y

MECH 3305  Computer Aided Design (3 semester hours) Lecture course. Course material includes an introduction to Computer-Aided Mechanical Design (CAMD) tools and their applications to mechanical systems design. Prerequisites: MECH 1208 and ENGR 2300 and PHYS 2325. Prerequisite or corequisite: CS 1325 or (CE 1337 or CS 1337 or TE 1337). Corequisite: MECH 3105. (3-0) Y

MECH 3310  Thermodynamics (3 semester hours) Lecture course. This course focuses on introductory concepts and definitions of thermodynamics, energy and the availability and reversible work, machine, and cycle processes; real gas behavior; first law of thermodynamics, phase-change, internal energy, energy balance, entropy, ideal gas, control volume analysis, second law of thermodynamics, vapor, gas and refrigeration power systems. Prerequisites: MECH 1208 and ENGR 3300 and PHYS 2325. Prerequisite or corequisite: CHEM 1311. (3-0) Y

MECH 3315  Fluid Mechanics (3 semester hours) Lecture course. Course material includes the concepts and applications of fluid mechanics and dimensional analysis with an emphasis on fluid behavior, internal and external flows, analysis of engineering applications of incompressible pipe systems, and external aerodynamics, ideal fluid flow including potential flow theory, and computer solutions in ideal fluid flow. Prerequisites: MECH 2330 and ENGR 3300. Prerequisite or corequisite: MECH 3310. (3-0) Y

MECH 3320  Heat Transfer (3 semester hours) Lecture course. This course focuses on the steady and unsteady conduction in one- and two-dimensions; forced convection, internal and external flows; heat exchangers; introduction to radiation; elements of thermal system design. Prerequisites: MECH 3310 and MECH 3315. (3-0) Y

MECH 3350  Kinematics and Dynamics of Mechanical Systems (3 semester hours) Lecture course. Motion and interaction of machine elements and mechanisms. Kinematics, statics, and dynamics are applied for analysis and design of the parts of machines such as planar mechanisms, cams and gears. Prerequisites: ENGR 2300 and MATH 2420 and MECH 2330 and ENGR 3300. (3-0) Y

MECH 3351  Design of Mechanical Systems (3 semester hours) Lecture course. Design and analysis tools for mechanical systems. Design criteria based on reliability and functionality are introduced. Basic principles of stress and deflection analysis, application to mechanical components and systems. Failure design theory based on static and dynamic loads, stochastic considerations, and design of mechanical components such as shafts, bearing and shaft-bearing systems, gear and gear systems and mechanical joints. Prerequisites:
**MECH 2320** and **ENGR 3300**. Prerequisite or corequisite: **MECH 3350**. (3-0) Y

**MECH 3v95** Topics in Mechanical Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated as topics vary (9 hours maximum). ([1-9]-0) R

**MECH 4110** Systems and Controls Laboratory (1 semester hour) Laboratory course associated with **MECH 4310**. Course focused on the modeling and parameter estimation of dynamical systems, and the design of control systems. Prerequisite: **MECH 4310**; it is recommended that the laboratory is taken the next long semester after completion of **MECH 4310**. (0-1) Y

**MECH 4310** Systems and Controls (3 semester hours) Lecture course. Introduction to linear control theory. General structure of control systems. Mathematical models including differential equations, transfer functions, and state space. Transient response and steady-state error. Performance, stability, root-locus method, Bode diagram, and Nyquist plot. Compensation design using PID, phase-lead, and phase-lag controllers. Prerequisites: **ENGR 2300** and **MATH 2420** and **MECH 2330**. Prerequisite or corequisite: **MECH 3315**. (3-0) Y

**MECH 4330** Intermediate Fluid Mechanics (3 semester hours) Lecture course. This course covers ideal fluid flow, including potential flow theory, computer solutions in ideal fluid flow, viscous flow and boundary layer theory and introduction to turbulence. Prerequisite: **MECH 3315**. (3-0) Y

**MECH 4340** Mechanical Vibrations (3 semester hours) Lecture course. This course covers harmonic and periodic motion including both damped and undamped free and forced vibration, single- and multi-degree-of-freedom systems and matrix techniques suitable for computer simulations. Prerequisites: **ENGR 2300** and **MATH 2420** and **ENGR 3341** and **MECH 2330**. (3-0) Y

**MECH 4350** Applied Heat Transfer (3 semester hours) Lecture course. This course extends topics beyond those found in the first course in heat transfer (**MECH 3320**), as well as introducing multi-mode heat transfer analyses. More complex heat transfer problems, both transient and steady state, are introduced. Examples of current heat transfer applications are incorporated into the course material. Prerequisite: **MECH 3320**. (3-0) Y

**MECH 4360** Introduction to Nanostructured Materials (3 semester hours) Lecture course. The emphasis in this course is to introduce the science of the building blocks of nanostructured materials, their chemical and structural characterization, material behavior, and the technological implications of these materials. Special attention is devoted to presenting new developments in this field and future perspectives. Prerequisites: **CHEM 1311** and **MECH 3301**. (3-0) Y

**MECH 4370** Introduction to MEMS (3 semester hours) Lecture course. This course will target an audience of motivated senior-level undergraduates, with the goal of providing an introduction to M/NEMS fabrication techniques, selected device applications, and the design tradeoffs in developing systems. Prerequisites: **CHEM 1311** and **MECH 3310** and **MECH 3350**. (3-0) Y

**MECH 4381** Senior Design Project I (3 semester hours) Project-based capstone course. Student groups design, build, and test a device that solves an open-ended mechanical engineering design problem. **MECH 4381** focuses on background research and engineering analysis, **MECH 4382** on prototype construction and testing. As a designated MECH Writing-Intensive Course, **MECH 4381** and **MECH 4382** also focus on the refinement of students' engineering communications skills and their use of writing as a critical-thinking
and learning tool. Prerequisites: MECH 3305 and MECH 3320 and MECH 3351 and MECH 4310 and ECS 3390. (3-0) Y

**MECH 4382** Senior Design Project II (3 semester hours) Project-based capstone course. Student groups design, build, and test a device that solves an open-ended mechanical engineering design problem. MECH 4381 focuses on background research and engineering analysis, MECH 4382 on prototype construction and testing. As a designated MECH Writing-Intensive Course, MECH 4381 and MECH 4382 also focus on the refinement of students' engineering communications skills and their use of writing as a critical-thinking and learning tool. Prerequisite: MECH 4381. (3-0) Y

**MECH 4399** Senior Honors in Mechanical Engineering (3 semester hours) For students conducting independent research for honors theses or projects. (3-0) R

**MECH 4v95** Topics in Mechanical Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated as topics vary (9 hours maximum). ([1-9]-0) R

**MECH 4v98** Undergraduate Research in Mechanical Engineering (1-9 semester hours) Topics will vary from semester to semester. May be repeated for credit (9 hours maximum). Instructor consent required. ([1-9]-0) R

## Nanoscience

**NANO 3301** Introduction to Nanoscience and Nanotechnology (3 semester hours) Introduction to the underlying principles and applications of the emerging field of nanotechnology and nanoscience. Intended for a multidisciplinary audience with a variety of backgrounds. Introduces tools and principles relevant at the nanoscale dimension. Discusses current and future nanotechnology applications in engineering, materials, physics, chemistry, biology, electronics, and energy. Prerequisites: CHEM 1311, MATH 2419 or MATH 2415, PHYS 2326 or instructor consent required. (Same as ECS 3301) (3-0) Y

**NANO 3302** Microscopy, Spectroscopy, and Nanotech Instrumentation (3 semester hours) The instructor will guide students in learning and practicing the techniques for using laboratory instruments common to the field of nanotechnology. Techniques include ion scattering, electron spectroscopy, diffraction, Raman and UV-vis-NIR spectroscopy, SEM, SFM, and thin film growth/deposition and processing. Prerequisites: CHEM 1311, MATH 2419 or MATH 2415, PHYS 2326 or instructor consent required. (3-0) Y

**NANO 3310** Introduction to Materials Science (3 semester hours) This course provides an intensive overview of materials science and engineering focusing on how structure/property/processing relationships are developed and used for different types of materials. The course illustrates roles of materials in modern technology by case studies of advances in new materials and process. Topics include atomic structure, crystalline solids, defects, failure mechanisms, phase diagrams and transformations, metal alloys, ceramics, polymers as well as their mechanical, thermal, electrical, magnetic and optical properties. Prerequisites: CHEM 1311, MATH 2419 or MATH 2415, PHYS 2326 or instructor consent required. (Same as ECS 3310) (3-0) Y

**NANO 4391** Technology of Plasma (3 semester hours) Plasmas are critical to making the best electronic devices. This class will be an introduction to the technology required to make and use these plasmas. Topics include: high-vacuum technology (gas properties, pumps, pressure gauges, flow-meters, gas
composition analysis) and plasma technology (etch, deposition, and lamps). Prerequisites: ENGR 3300 and (CE 3310 or EE 3310). Recommended: ENGR 3341. (Same as EE 4391) (3-0) Y

**NANO 4v95 Undergraduate Research in Nanotechnology** (1-9 semester hours) Provides students with experience in a laboratory setting. A total of at most 6 hours can be counted towards the minor. Hands-on opportunity to interact with professors and companies in the field. May be repeated (9 hours maximum). Pre- or corequisites: NANO 3301 and NANO 3302, or instructor consent required. ([1-9]-0) S

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## Software Engineering

**SE 2v95** Individual Instruction in Software Engineering (1-6 semester hours) Individual study under a faculty member's direction. May be repeated for credit as topics vary (6 hours maximum). Instructor consent required. ([1-6]-0) R


**SE 3306** Mathematical Foundations of Software Engineering (3 semester hours) Boolean logic, first-order logic, models of first-order logic. Introduction to program verification, applications in software engineering. Completeness Theorem. Regular expressions, regular sets, finite-state machines, and applications in software engineering. Graph Theory, graph algorithms. Statecharts, Petri Nets and their role in software engineering. Prerequisite: CE 2305 or CS 2305 or TE 2305 or equivalent. (3-0) S

**SE 3340** Computer Architecture (3 semester hours) This course introduces the concepts of computer architecture by going through multiple levels of abstraction, and the numbering systems and their basic computations. It focuses on the instruction-set architecture of the MIPS machine, including MIPS assembly programming, translation between MIPS and C, and between MIPS and machine code. General topics include performance calculation, processor datapath, pipelining, and memory hierarchy. Students who have already completed CS 2310 or equivalent cannot receive credit for this course. Students cannot receive credit for both (CS 3340 or SE 3340 or TE 3340) and (CE 4304 or EE 4304). Prerequisites: (CE 1337 or CS 1337 or TE 1337 or equivalent) and (CE 2305 or CS 2305 or TE 2305). (Same as CS 3340 and TE 3340) (3-0) S

**SE 3341** Probability and Statistics in Computer Science and Software Engineering (3 semester hours) Axiomatic probability theory, independence, conditional probability. Discrete and continuous random variables, special distributions of importance to CS/SE, and expectation. Simulation of random variables and Monte Carlo methods. Central limit theorem. Basic statistical inference, parameter estimation, hypothesis testing, and linear regression. Introduction to stochastic processes. Illustrative examples and simulation exercises from queuing, reliability, and other CS/SE applications. Students cannot get credit for both (CS 3341 or SE 3341 or STAT 3341) and ENGR 3341. Prerequisites: (MATH 1326 or MATH 2414 or MATH 2419), and (CE 2305 or CS 2305 or TE 2305). (Same as CS 3341 and STAT 3341) (3-0) S
SE 3345 Data Structures and Introduction to Algorithmic Analysis (3 semester hours) Analysis of algorithms including time complexity and Big-O notation. Analysis of stacks, queues, and trees, including B-trees. Heaps, hashing, and advanced sorting techniques. Disjoint sets and graphs. Course emphasizes design and implementation. Students that completed CE 3346 or TE 3346 cannot receive credit for this course. Prerequisites: (CE 2305 or CS 2305 or TE 2305) and (CE 2336 or CS 2336 or TE 2336). Prerequisite or corequisite: CS 3341 or SE 3341 or ENGR 3341. (Same as CE 3345 and CS 3345 and TE 3345) (3-0) S

SE 3354 Software Engineering (3 semester hours) Introduction to software life cycle models. Software requirements engineering, formal specification and validation. Techniques for software design and testing. Cost estimation models. Issues in software quality assurance and software maintenance. Prerequisites: (CE 2336 or CS 2336 or TE 2336 or CS 3333), and (CE 2305 or CS 2305 or TE 2305 or equivalent). Prerequisite or corequisite: ECS 3390. (Same as CE 3354 and CS 3354) (3-0) S

SE 3376 C/C++ Programming in a UNIX Environment (3 semester hours) Advanced programming techniques utilizing procedural and object oriented programming in a UNIX environment. Topics include file input and output, implementation of strings, stacks, queues, lists, and trees, and dynamic memory allocation/management. Design and implementation of a comprehensive programming project is required. Prerequisite: CE 2336 or CS 2336 or TE 2336 or equivalent. (Same as CS 3376) (3-0) S

SE 3n95 Undergraduate Topics in Software Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 hours maximum). ([1-9]-0) S

SE 4347 Database Systems (3 semester hours) This course emphasizes the concepts and structures necessary for the design and implementation of database management systems. Topics include data models, data normalization, data description languages, query facilities, file organization, index organization, file security, data integrity, and reliability. Prerequisite: CE 3345 or CS 3345 or SE 3345 or TE 3345. (Same as CS 4347) (3-0) Y

SE 4348 Operating Systems Concepts (3 semester hours) An introduction to fundamental concepts in operating systems: their design, implementation, and usage. Topics include process management, main memory management, virtual memory, I/O and device drivers, file systems, secondary storage management, and an introduction to critical sections and deadlocks. Prerequisites: (CS 3340 or SE 3340 or TE 3340 or equivalent), and (CE 3345 or CS 3345 or SE 3345 or TE 3345), and a working knowledge of C and UNIX. (Same as CE 4348 and CS 4348 and TE 4348) (3-0) S

SE 4351 Requirements Engineering (3 semester hours) Introduction to system and software requirements engineering. The requirements engineering process, including requirements elicitation, specification, and validation. Essential words and types of requirements. Structural, informational, and behavioral requirements. Non-functional requirements. Scenario analysis. Conventional, object-oriented and goal-oriented methodologies. Prerequisites: SE 3306 and (CE 3354 or CS 3354 or SE 3354) or instructor consent required. (3-0) S

SE 4352 Software Architecture and Design (3 semester hours) Introduction to software design with emphasis on architectural design. Models of software architecture. Architecture styles and patterns, including explicit, event-driven, client-server, and middleware architectures. Decomposition and composition of architectural components and interactions. Use of non-functional requirements for tradeoff analysis. Component based software development, deployment and management. Prerequisites:
SE 3306 and (CE 3354 or CS 3354 or SE 3354) or instructor consent required. (3-0) S

SE 4367 Software Testing, Verification, Validation and Quality Assurance (3 semester hours) Methods for evaluating software for correctness and reliability, including code inspections, program proofs and testing methodologies. Formal and informal proofs of correctness. Code inspections and their role in software verification. Unit and system testing techniques, testing tools and limitations of testing. Statistical testing, reliability models. Prerequisites: SE 3306 and (CE 3354 or CS 3354 or SE 3354) or instructor consent required. (3-0) S

SE 4376 Object-Oriented Programming Systems (3 semester hours) In-depth study of the features/advantages of object-oriented approach to problem solving. Special emphasis on issues of object-oriented analysis, design, implementation, and testing. Review of basic concepts of object-oriented technology (abstraction, inheritance, and polymorphism). Object-oriented programming languages, databases, and productivity tools. Prerequisite: CE 2336 or CS 2336 or TE 2336 or equivalent. (Same as CS 4376) (3-0) S

SE 4381 Software Project Planning and Management (3 semester hours) Planning and managing of software development projects. Software process models, ISO 9000, SEI's Capability Maturity Model, continuous process improvement. Planning, scheduling, tracking, cost estimation, risk management, configuration management. Prerequisite: CE 3354 or CS 3354 or SE 3354. (3-0) Y

SE 4399 Senior Honors in Software Engineering (3 semester hours) For students conducting independent research for honors theses or projects. Topics may vary. (3-0) R

SE 4485 Software Engineering Project (4 semester hours) This course is intended to complement the theory and to provide an in-depth, hands-on experience in all aspects of software engineering. The students will work in teams on projects of interest to industry and will be involved in analysis of requirements, architecture and design, implementation, testing and validation, project management, software process, software maintenance, and software re-engineering. Students will also explore the potential impact of software systems on society. Additionally, this course will cover topics related to the software engineering profession including ethics and professional responsibility, entrepreneurship, and leadership. Prerequisites: at least two of SE 4351, SE 4352, SE 4367, SE 4381. (4-1) S

SE 4v95 Undergraduate Topics in Software Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be used as SE Guided Elective on SE degree plans. May be repeated for credit as topics vary (9 hours maximum). ([1-9]-0) R

SE 4v98 Undergraduate Research in Software Engineering (1-9 semester hours) Topics will vary from semester to semester. May be repeated for credit (9 hours maximum). Instructor consent required. ([1-9]-0) R

Telecommunications Engineering

TE 1202 Introduction to Electrical Engineering (2 semester hours) TE 1202 introduces the discipline of engineering. It includes a 1.5-hour lecture per week plus a 3-hour fundamentals laboratory that stresses learning about laboratory procedures and equipment. Topics include: Learning the use of common laboratory electronic equipment; understanding the assembly of electronic circuits; and making various measurements. Students also learn how to work together with a partner and how to write a laboratory
report. The lecture introduces general engineering practices, engineering research at UTD, engineering activities at selected local companies, and concepts such as innovation and invention. The course also includes lectures and projects on communication, understanding the importance of lifelong learning, ethics, and a knowledge of contemporary issues. **TE 1202** may be taken by students outside of engineering in order to learn about the engineering profession. (Same as **CE 1202** and **EE 1202**) (1.5-3) S

**TE 1337 (COSC 1337)** Computer Science I (3 semester hours) Introduction to object-oriented software analysis, design, and development. Classes and objects. Object composition and polymorphism. Sorting, searching, recursion. Strings using core classes. Inheritance and interfaces. Graphical User Interfaces. Includes a comprehensive programming project. Prerequisite: **CS 1336** with a grade of C or better or equivalent. (Same as **CE 1337** and **CS 1337**) (3-0) S

**TE 2305 (MATH 2305)** Discrete Mathematics for Computing I (3 semester hours) Principles of counting, Logic and proof methods, including induction. Basic recurrence relations. Basics of algorithm complexity. Sets, relations, functions. Elementary graph theory. Elementary number theory. Students cannot get credit for both **TE 2305** and (**CE 3307** or **TE 3307**). Prerequisite: **MATH 1326** or **MATH 2413** or **MATH 2417**. (Same as **CE 2305** and **CS 2305**) (3-0) S

**TE 2336 (COSC 2336)** Computer Science II (3 semester hours) Exceptions and number formatting. File input/output using Stream classes. Implementation of primitive data structures, including linked lists (all types), stacks, queues, and binary trees. Advanced data manipulation using core classes. Introduction to multi-threading, multimedia, and networking. Includes a comprehensive programming project. Prerequisite: **CE 1337** or **CS 1337** or **TE 1337**. Prerequisite or corequisite: **CE 2305** or **CS 2305** or **TE 2305**. (Same as **CE 2336** and **CS 2336**) (3-0) S

**TE 3101** Electrical Network Analysis Laboratory (1 semester hour) Laboratory to accompany **TE 3301**. Design, assembly and testing of linear electrical networks and systems. Use of computers to control electrical equipment and acquire data. Prerequisites: (**CE 1202** or **EE 1202** or **TE 1202**) and **RHET 1302**. Corequisite: **TE 3301**. (Same as **CE 3101** and **EE 3101**) (0-1) S

**TE 3102** Signals and Systems Laboratory (1 semester hour) Laboratory based on MATLAB and LabVIEW to provide implementation experience on topics covered in **TE 3302**. Laboratory experiments cover linear time-invariant systems, convolution, Fourier series, continuous Fourier transform, sampling, discrete Fourier transform, analog and digital filtering. Each lab is followed by a design application. Corequisite: **TE 3302**. Prerequisite: **RHET 1302**. (Same as **CE 3102** and **EE 3102**) (0-1) S

**TE 3150** Communications Systems Laboratory (1 semester hour) Laboratory to accompany **TE 3350**. Fundamental elements of communications systems hardware; use of spectrum analyzers and other measurement instruments typically encountered in communication systems; design of active filters in communications systems; analog frequency and amplitude modulators and demodulators; data communication systems. Corequisite: **TE 3350**. Prerequisite: (**CE 3301** or **EE 3301** or **TE 3301**) and **RHET 1302**. (Same as **EE 3150**) (0-1) S

**TE 3301** Electrical Network Analysis (3 semester hours) Analysis and design of RC, RL, and RLC electrical networks. Sinusoidal steady state analysis of passive networks using phasor representation; mesh and nodal analyses. Introduction to the concept of impulse response and frequency analysis using the Laplace transform. Prerequisites: **MATH 2420** and **PHYS 2326**. Corequisite: **TE 3101**. (Same as **CE 3301** and **EE 3301**)
Signals and Systems (3 semester hours) Introduces the fundamentals of continuous and discrete-time signal processing. Linear system analysis including convolution and impulse response, Fourier series, Fourier transform and applications, discrete-time signal analysis, sampling and z-transform. Prerequisite: ENGR 3300. Corequisite: TE 3102. (Same as CE 3302 and EE 3302) (3-0) S

Computer Architecture (3 semester hours) This course introduces the concepts of computer architecture by going through multiple levels of abstraction, and the numbering systems and their basic computations. It focuses on the instruction-set architecture of the MIPS machine, including MIPS assembly programming, translation between MIPS and C, and between MIPS and machine code. General topics include performance calculation, processor datapath, pipelining, and memory hierarchy. Students who have already completed CS 2310 or equivalent cannot receive credit for this course. Students cannot receive credit for both (CS 3340 or SE 3340 or TE 3340) and (CE 4304 or EE 4304). Prerequisites: (CE 1337 or CS 1337 or TE 1337 or equivalent) and (CE 2305 or CS 2305 or TE 2305). (Same as CS 3340 and SE 3340) (3-0) S

Data Structures and Introduction to Algorithmic Analysis (3 semester hours) Analysis of algorithms including time complexity and Big-O notation. Analysis of stacks, queues, and trees, including B-trees. Heaps, hashing, and advanced sorting techniques. Disjoint sets and graphs. Course emphasizes design and implementation. Students that completed CE 3346 or TE 3346 cannot receive credit for this course. Prerequisites: (CE 2305 or CS 2305 or TE 2305) and (CE 2336 or CS 2336 or TE 2336). Prerequisite or corequisite: CS 3341 or SE 3341 or ENGR 3341. (Same as CE 3345 and CS 3345 and SE 3345) (3-0) S

Communications Systems (3 semester hours) Fundamentals of communications systems. Review of probability theory and Fourier transforms. Filtering and noise. Modulation and demodulation techniques, including amplitude, phase, and pulse code. Time division multiplexing. This class may be offered as either regular or honors sections (H). Prerequisites: ENGR 3300 and (CE 3301 or EE 3301 or TE 3301) and (CE 3302 or EE 3302 or TE 3302) and ENGR 3341. Corequisite: EE 3150 or TE 3150. (Same as EE 3350) (3-0) S

Digital Systems Laboratory (1 semester hour) Laboratory to accompany TE 4341. The purpose of this laboratory is to give students an intuitive understanding of digital circuits and systems. Laboratory exercises include construction of simple digital logic circuits using prototyping kits and board-level assembly of a personal computer. Students who have already completed CS 2110 cannot receive credit for this course. Corequisite: CS 4341 or TE 4341. (Same as CS 4141) (0-2) S

Digital Logic and Computer Design (3 semester hours) Boolean algebra and logic circuits; synchronous sequential circuits; gate level design of ALSU, registers, and memory unit; register transfer operations; design of data path and control unit for a small computer; Input-Output interface. Students cannot receive credit for both (CS 4341 or TE 4341) and (CE 3320 or EE 3320). Prerequisites: (CE 2310 or EE 2310) or (CS 3340 or SE 3340 or TE 3340) and PHYS 2326. Corequisite: (CS 4141 or TE 4141). (Same as CS 4341) (3-0) S

Operating Systems Concepts (3 semester hours) An introduction to fundamental concepts in operating systems: their design, implementation, and usage. Topics include process management, main memory management, virtual memory, I/O and device drivers, file systems, secondary storage
management, and an introduction to critical sections and deadlocks. Prerequisites: (CS 3340 or SE 3340 or TE 3340 or equivalent), and (CE 3345 or CS 3345 or SE 3345 or TE 3345), and a working knowledge of C and UNIX. (Same as CE 4348 and CS 4348 and SE 4348) (3-0) S

**TE 4360** Digital Communications (3 semester hours) Information, digital transmission, channel capacity, delta modulation, and differential pulse code modulation are discussed. Principles of coding and digital modulation techniques such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Continuous Phase Frequency Shift Keying (CPFSK) are introduced. M-ary signaling such as Quadrature amplitude and phase shift keying, and M-ary PSK and FSK are also discussed. Prerequisite: EE 3350 or TE 3350. (Same as EE 4360) (3-0) T

**TE 4361** Introduction to Digital Signal Processing (3 semester hours) An introduction to the analysis and design of discrete linear systems, and to the processing of digital signals. Topics include time and frequency domain approaches to discrete signals and systems, the Discrete Fourier Transform and its computation, and the design of digital filters. Prerequisite: CE 3302 or EE 3302 or TE 3302. (Same as EE 4361) (3-0) T

**TE 4365** Introduction to Wireless Communication (3 semester hours) Introduction to the basic system concepts of cellular telephony. Mobile standards, mobile system architecture, design, performance and operation. Voice digitization and modulation techniques; PCS technologies. Prerequisite: EE 3350 or TE 3350. (Same as EE 4365) (3-0) Y

**TE 4367** Telecommunication Networks (3 semester hours) Trunking and queuing, switching technologies: voice, data, video, circuit switching and packet switching, transmission technologies and protocols, transmission media - copper, fiber, microwave, satellite, protocols - bipolar formats, digital hierarchy, optical hierarchy, synchronization, advanced switching protocols and architectures; frame relay, ATM, HDTV, SONET. Prerequisite or Corequisite: EE 3350 or TE 3350. (Same as EE 4367) (3-0) Y

**TE 4388** Senior Design Project I (3 semester hours) First of two sequential semesters devoted to a team project that engages students in the full engineering design process. The goal of senior design projects is to prepare the student to run/participate in engineering projects related to an appropriate industry. Thus, all project teams are to follow standard industrial practices and methods. Teams must carry the engineering project to completion, examining real world and multiple design constraints, following applicable industrial and business standards. Such constraints may include but are not limited to: economic, environmental, industrial standards, team time/resource management and cross-disciplinary/departamental result integration. Students are required to work in teams that include collaborative design interaction. Additionally, cross-disciplinary teams are encouraged but not required. In Senior Design I, project proposals will be written, reviewed and approved. Initial designs will be completed and corresponding constraints will be determined. All students will participate in a public oral and poster presentation following departmental approved guidelines at a departmental approved time and location. Teams will also submit a written end of semester progress report and documented team communication (complete sets of weekly reports and/or log books) following guidelines approved by the faculty. Students must have completed ECS 3390 and one of the following prerequisite sequences: ((CE 3311 or EE 3311), and (CE 3320 or EE 3320), and (CE 3345 or CS 3345 or SE 3345 or TE 3345), and (CE 3354 or CS 3354 or SE 3 354)), or ([(ENGR 3300 and (CE 3302 or EE 3302 or TE 3302), and (CE 3311 or EE 3311), and (CE 3320 or EE 3 320), or (ENGR 3300 and (CE 3302 or EE 3302 or TE 3302), and (CE 3345 or CS 3345 or SE 3345 or TE 334 5)); prerequisite or corequisite: EE 3350 or TE 3350.] (Same as CE 4388 and EE 4388) (3-0) S

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**TE 4389** Senior Design Project II (3 semester hours) Continuation of the Senior Design project begun in the previous semester. In Senior Design II, projects based on approved project proposals will be completed. All limitations of the design will be determined and addressed. All students will participate in a public oral presentation following faculty-approved guidelines at a faculty-approved time and location. Teams will also submit a written final report and documented team communication (complete sets of weekly reports and/or log books) following faculty-approved guidelines. Prerequisite: [CE 4388](#) or [EE 4388](#) or [TE 4388](#). (Same as [CE 4389](#) and [EE 4389](#)) (3-0) S

**TE 4390** Computer Networks (3 semester hours) The design and analysis of computer networks. Topics include the ISO reference model, transmission media, medium-access protocols, LANs, data link protocols, routing, congestion control, internetworking, and connection management. Students cannot get credit for both [CE 4390](#) or [CS 4390](#) or [TE 4390](#) and [EE 4390](#). Prerequisite: [CE 3345](#) or [CS 3345](#) or [SE 3345](#) or [TE 3345](#) or equivalent. (Same as [CE 4390](#) and [CS 4390](#)) (3-0) S

**TE 4v95** Undergraduate Topics in Telecommunications Engineering (1-9 semester hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 hours maximum). ([1-9]-0) R

**TE 4v98** Undergraduate Research in Telecommunications Engineering (1-9 semester hours) May be repeated for credit as topics vary (9 hours maximum). This course may be used as an honors course. Instructor consent required. ([1-9]-0) R