Biomedical Engineering

BMEN 1100 Introduction to Bioengineering I (1 semester credit hour) This is a laboratory course emphasizing the essential skills and tools necessary to succeed in a biomedical engineering degree plan. Lab activities will include an introduction to laboratory instruments applicable to the field of biomedical engineering, measurement techniques, and basic statistical analysis of real-world experimental data. Professional responsibilities in biomedical engineering will be evaluated as well as engineering ethics. CE 1100 or CS 1200 or EE 1100 or MECH 1100 can substitute for this course. Credit cannot be received for more than one of the following: BMEN 1100, CE 1100, CS 1200, EE 1100 or MECH 1100. Lab fee of $30 required. (0-2) Y

BMEN 1208 Introduction to Bioengineering II (2 semester credit hours) The purpose of this course is to give students a general understanding of a broad range of applications specific to the biomedical engineering profession. Course exercises include team-oriented project, computer-aided design, introductory materials, and hardware and software tools associated with the discipline. Lab fee of $30 required. Prerequisite: BMEN 1100. Prerequisite or Corequisite: BMEN 1300 or equivalent. (1-2) Y

BMEN 1300 Introduction to Biomedical Engineering Computing (3 semester credit hours) Computer programming in a high-level, block structured language with a focus on bioengineering applications. Basic data types, memory usage, control structures, input/output, functions and parameter passing. Program design and software development methodology. Mechanics of running, testing, and debugging. Pseudo-codes, flowcharts and code efficiency. Programming languages of choice are C++ and Matlab. Programming projects related to biomedical engineering applications. (3-0) S

BMEN 2320 Statics (3 semester credit 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: PHYS 2325 and PHYS 2125. Prerequisites or Corequisites: MATH 2415 or MATH 2419 or equivalent. (3-0) S

BMEN 2V99 Topics in Biomedical Engineering (1-4 semester credit hours) May be repeated as topics vary (9 semester credit hours maximum). ([1-4]-0) R

BMEN 3110 Biomedical Transport Processes Laboratory (1 semester credit hour) Laboratory course. Lab fee of $30 required. Prerequisite: RHET 1302. Prerequisite or Corequisite: BMEN 3310. (0-3) Y

BMEN 3120 Biomedical Circuits and Instrumentation Laboratory (1 semester credit hour) Laboratory course. This course will include a brief recitation (discussion) session prior to each lab. Lab fee of $30 required. Prerequisite or Corequisite: BMEN 3320. Prerequisite: RHET 1302. (0-3) Y

BMEN 3130 Engineering Physiology Laboratory (1 semester credit hour) Laboratory course. Lab fee of $30 required. Prerequisite: RHET 1302. Prerequisite or Corequisite: BMEN 3330. (0-3) Y

BMEN 3150 Biomedical Engineering Laboratory (1 semester credit hour) Laboratory course. Lab fee of $30 required. Prerequisite or Corequisite: BMEN 3350. Prerequisite: RHET 1302. (0-3) Y

BMEN 3200 Biomedical Engineering Fundamentals and Design (2 semester credit hours) This course will cover the fundamentals of biomedical engineering and design techniques through a combination of labs, lectures, and a guided design project. Students will learn the broad fundamentals of biomedical engineering and also the design process including such topics as ethical behavior, particularly with respect to human and animal subjects, intellectual property considerations, global biomedical engineering, codes and standards, and FDA regulations. The students will receive hands-on training on machining, wetlab techniques, computer-aided modeling and simulation, basic electrical and electronic circuit design and computer programming. Completion of this course will provide students with the skills and knowledge to enable them to be successful in future design courses. Prerequisites: BMEN 3220 and BMEN 3320 and BMEN 3331 and BMEN 3399. Corequisite: BMEN 4310. (0-2) Y

BMEN 3220 Electrical and Electronic Circuits in Biomedical Engineering Lab (2 semester credit hours) Experiments in this course teach students the applications of and skills related to the following concepts: (i) Analysis methods and network theorems used to describe the operation of electric circuits, (ii) Electrical quantities, linear circuit elements, signal waveforms, transient and steady state circuit behavior, (iii) Diode, transistor, and op amp based circuits such as filters, amplifiers, rectifiers, etc., (iv) Modeling, analysis and simulation of electrical circuits in biomedical engineering, (v) PCB design and soldering, (vi) Microcontroller programming, (vii) Signal conditioning circuit design for microcontrollers, (viii) Integration of analog and digital sensors and peripherals with microcontrollers, (ix) Acquisition and analysis of biosignals, and processing both in analog and digital domains, (x) Design and implementation of embedded sensor systems for biomedical applications. Lab fee of $30 required. Prerequisites: MATH 2420 and PHYS 2326 and PHYS 2126. Corequisite or Prerequisite: CS 1324 or BMEN 1300. (0-2) Y

BMEN 3302 Bioengineering Signals and Systems (3 semester credit hours) In this course, the fundamentals of continuous and discrete-time signal processing relevant to Biomedical Engineering and biomedical devices are introduced. The main time and frequency-domain concepts covered in the course are convolution, impulse response, Fourier transform, and sampling theorem. Credit cannot be received for more than one of the following: BMEN 3302 or BMEN 3402 or CE 3303 or EE 3302. Prerequisites: BMEN 1208 and ENGR 3300. (3-0) Y

BMEN 3310 Fluid Mechanics and Transport Processes in Biomedical Engineering (3 semester credit 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. Prerequisites: BMEN 1208 and ENGR 3300. (3-0) Y

BMEN 3315 Thermodynamics and Physical Chemistry in Biomedical Engineering (3 semester credit 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: (CHEM 1301 or (CHEM 1311 and CHEM 1312)) and (CHEM 2324 or (CHEM 2323 and CHEM 2325)) and (MATH 2415 or MATH 2419 or equivalent) and (PHYS 2126 and PHYS 2326). (3-0) Y

BMEN 3318 Introduction to Engineered Biomaterials (3 semester credit hours) The properties and processing of engineered materials used in biomedical devices are taught with an emphasis on the chemistry and structure-property relationships that control the mechanical, corrosion, and biocompatibility of materials used in acute and chronically implanted medical devices. Topics include the crystalline and amorphous states of metals, glasses and polymers, glass formation and bioactive glasses, mechanical properties, corrosion emphasizing passivity and galvanic corrosion, phase diagrams, macromolecular bonding and structure, and an introduction to material-tissue interactions related to the chemical stability of implants. The course also introduces basic material characterization techniques including uniaxial tensile tests, x-ray-diffraction, SEM/optical microscopy, potentiodynamic polarization, infrared spectroscopy, and differential scanning calorimetry. Materials covered include the stainless steels, CoCr-alloys, titanium alloys, polymers and oxide ceramics used in arthroplasty, and biodegradable polymers including drug-eluting polymers. Prerequisites or Corequisites: BMEN 1208 and (CHEM 1312 or CHEM 1301). (3-0) Y

BMEN 3320 Electrical and Electronic Circuits in Biomedical Engineering (3 semester credit 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. It is recommended that students take BMEN 3120 with this course. Prerequisites: MATH 2420 and (PHYS 2126 and PHYS 2326). Prerequisite or Corequisite: CS 1324 or BMEN 1300. (3-0) Y

BMEN 3325 Advanced Computational Tools for Biomedical Engineering (3 semester credit hours) MATLAB is an increasingly important tool for solving data-driven Bioengineering/Biomedical Engineering (BE/BME) problems. MATLAB is both a programming language and a platform with toolboxes for data acquisition, processing, visualization, analysis, as well as simulation. This course will provide an extensive training on how to use these advanced engineering tools in MATLAB. These tools could work either with hardware or as independent software. Advanced topics in programming and programming skills for solving biomedical problems. Advanced topics in programming and computational models will be introduced in lectures. Class assignments, home assignments, and class projects will be used for practice and training. The course will help students to be better prepared for their junior, senior, graduate study, or professional work. Prerequisite: BMEN 1208. (1.5-1.5) Y

BMEN 3330 Engineering Physiology of the Human Body (3 semester credit 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. Students will learn to apply engineering tools and concepts to understand normal and abnormal physiology. It is recommended that students take BMEN 3130 with this course. Prerequisite: BIOL 2311. (3-0) S

BMEN 3331 Cell and Molecular Engineering (3 semester credit hours) This course will cover physiological function from a cellular, molecular, and biophysical perspective, with applications to bioengineering design. Topics include protein structure and function, enzymes, the structure and nature of DNA, gene expression, protein trafficking, the cellular structure and function of various cellular organelles. Modern methods for designing, producing, and characterizing novel proteins and peptides will be examined. Students will also learn about energy and the function of mitochondria, cellular communication and the function of the extracellular matrix, cell motility, cell division, cell signaling, and cell adhesion. Prerequisite: MATH 2420. Prerequisite or Corequisite: CHEM 2324 or (CHEM 2325 and CHEM 2125). (3-0) S

BMEN 3332 Quantitative Physiology for Engineers (3 semester credit hours) This course in quantitative physiology will examine systems and organ level physiology of the human body. Content will be geared toward that relevant for bioengineers, with a focus on a quantitative, model-oriented, and control systems approach to physiological function. The topics covered include neural systems, the cardiovascular system, the respiratory system, the renal system, the endocrine system, and the immune system. In addition to physiological function in health, topics related to pathophysiology and engineering treatment strategies will be examined. Prerequisite: BMEN 3331. (3-0) S

BMEN 3341 Probability Theory and Statistics for Biomedical Engineers (3 semester credit hours) Probability theory, independence, Bayes' rule, normal distribution, central limit theorem. Graphical representation of data. Descriptive and inferential statistics with applications to biomedical engineering, hypothesis testing, confidence intervals, and linear regression. One sample, paired samples, and two independent samples methods. Credit cannot be received for both courses, (CS 3341 or SE 3341 or STAT 3341 or ENGR 3341) and BMEN 3341. Recommended Corequisite: MATH 2420. Prerequisite: MATH 2414 or MATH 2419. (3-0) S

BMEN 3350 Biomedical Component and System Design (3 semester credit 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. It is recommended that students take BMEN 3150 with this course. Prerequisite: BMEN 3320. Prerequisite or Corequisite: BMEN 3402 or EE 3302. (3-0) Y

BMEN 3370 Digital Circuits (3 semester credit hours) Digital circuit design, hardware structures, and hardware description language concepts that underlie the design of modern computer systems and their application to biomedical electronics. Topics include: internal data representation and arithmetic operations in a computer, Boolean logic, combinational logic circuits and sequential circuits. Design of arithmetic circuits, shifters and counters. Design and analysis of synchronous state machines. Hands-on laboratory experiments to design and analyze logic circuits using SSI, MSI and FPGAs. Use of Verilog to design and test circuits. Prerequisites: MATH 2420 and

(PHYS 2126 and PHYS 2326). (3-0) Y

BMEN 3380 Medical Imaging Systems and Methods (3 semester credit hours) In this course, the fundamental physical principals of modern medical imaging techniques will be covered, including x-ray, ultrasound, MRI, optical, and nuclear imaging. Emphasis will also be placed on imaging contrast agents, image processing, and multi-modality imaging. Prerequisite: EE 3302 or BMEN 3402. (3-0) R

BMEN 3399 Introductory Biomechanics (3 semester credit hours) The course covers both biosolid and biofluid mechanics. Covered topics include kinematics, stress, strain, equilibrium, extension, and torsion. Topics will be discussed in the context of biomedical engineering tools and biological tissue structure, function, and properties. Biofluid mechanics concepts will include stress, motion, balance relations (balance of mass, and balance of linear momentum), and their constitutive relations as well as flow between parallel plates and circular tubes. The latter lay the foundation for understanding fluid flow in the human body. Practical examples within the human body including examples of bone and artery loading mechanics will be incorporated. Selected basic concepts in biomaterials will be introduced in the context of biomechanical applications. Prerequisite: BMEN 2320. (3-0) R

BMEN 3402 Signals and Systems for Biomedical Engineering (4 semester credit hours) In this course, the fundamentals of continuous and discrete-time signal processing are introduced. The main time and frequency-domain concepts covered in the course are convolution, impulse response, Fourier transform, and sampling theorem. The course also acquaints students with signal processing in MATLAB. Credit cannot be received for more than one of the following: BMEN 3302 or BMEN 3402 or CE 3303 or EE 3302. Prerequisite: ENGR 3300. (4-0) Y

BMEN 3V99 Topics in Biomedical Engineering (1-4 semester credit hours) May be repeated as topics vary (9 semester credit hours maximum). Instructor consent required. ([1-4]-0) R

BMEN 4100 Professional Skills for Bioengineerings (1 semester credit hour) This course covers approaches for success leading to a professional career in Bioengineering. Topics include job search methods, interview preparation, and effective written and oral communication in technical environments. Guest speakers will include faculty and invited guests from the industry. Prerequisite: Junior-level standing or higher. (1-0) Y

BMEN 4110 Biomedical Feedback Systems Laboratory (1 semester credit hour) Laboratory course. Lab fee of $30 required. Corequisite: BMEN 4310. Prerequisite: RHET 1302. (0-3) Y

BMEN 4301 Introduction to Medical Device Development (3 semester credit hours) This course introduces students to some of the many factors influencing the design and development of medical devices over a product's lifespan. This course will examine medical devices in regards to ethics, entrepreneurship, clinical studies, regulatory affairs, and quality assurances. In addition to familiarizing students with the process of medical device development, this course helps students explore the variety of career options available to biomedical engineers. Prerequisites: RHET 1302 and Junior standing. (3-0) S

BMEN 4310 Feedback Systems in Biomedical Engineering (3 semester credit 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. It is recommended that students take BMEN 4110 with this course. It is strongly recommended that students take this course prior to BMEN 4388. Prerequisites: ENGR 2300 and MATH 2420. (3-0) Y

BMEN 4342 Introduction to Robotics (3 semester credit hours) Fundamentals of robotics, rigid motions, homogeneous transformations, forward and inverse kinematics, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Lab fee of $30 required. Prerequisite or Corequisite: BMEN 4310 or EE 4310 or MECH 4310 or equivalent. (Same as EE 4342 and MECH 4342) (2-3) Y

BMEN 4355 Finite Element Analysis in Biomedical Engineering (3 semester credit hours) The course will provide an introduction to the finite element method with an emphasis on applications in biomedical engineering. Traditionally rooted in structural engineering, finite element methods are used in simulating the mechanical response of the human body and medical devices. Theories will be reinforced through practical applications primarily using commercial simulation software. The course will also briefly cover methods of creating computational models from medical image sets. Prerequisites: (BMEN 3399 and ENGR 2300) or (senior status and instructor consent required). (3-0) Y

BMEN 4360 Biomaterials and Medical Devices (3 semester credit hours) Introduction to the field of biomaterials used in the design and engineering of medical devices, and to augment or replace soft and hard tissues. Discussion of bulk properties, applications, and in vivo behavior of different classes of natural and synthetic biomaterials. Analysis of biological response and biocompatibility, degradation and failure processes of implantable biomaterials/devices. Overview of regulatory compliance and performance requirements for commercialization of biomaterials and medical devices. Prerequisites or Corequisites: BMEN 2320 and (CHEM 1301 or (CHEM 1311 and CHEM 1312)) and (CHEM 2324 or (CHEM 2323 and CHEM 2325)). (3-0) Y

BMEN 4370 Biomedical Image Processing (3 semester credit hours) This course covers basic digital image processing techniques used for the analysis of biomedical images. Topics include a general introduction to the various biomedical imaging modalities, digital image fundamentals, intensity transformations, spatial and frequency domain filtering, image restoration and reconstruction, color image processing, image segmentation, and 3D data visualization. A large percentage of the course grade is based on laboratory exercises, which require students to program image processing techniques using MATLAB and apply them to digital images. Prerequisites: BMEN 3402 and experience with MATLAB Programming. (3-0) Y

BMEN 4375 Biomedical Engineering Data Analysis (3 semester credit hours) This course will introduce students to the data analysis techniques that are used by Biomedical Engineers to evaluate the large data streams that are being generated in the medical field related to genomic data, sensor data, and health care data. These techniques include pre-processing techniques, machine learning data analysis, and data visualization techniques. (3-0) Y

BMEN 4388 Senior Design Project I (3 semester credit 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. It is strongly recommended that students take BMEN 4310 prior to this course. Prerequisites: BMEN 3200 and ECS 3390. Corequisite: BMEN 3332. (3-0) Y

BMEN 4389 Senior Design Project II (3 semester credit 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 credit hours) For students conducting independent research for honors theses or projects. Instructor consent required. (3-0) R

BMEN 4V95 Undergraduate Topics in Biomedical Engineering (1-6 semester credit hours) For organized classes only (not for individual instruction). Subject matter will vary from semester to semester. May be repeated for credit as topics vary (6 semester credit hours maximum). Instructor consent required. Student must document School of Engineering content via a written report. ([1-6]-0) R

BMEN 4V97 Independent Study in Biomedical Engineering (1-6 semester credit hours) Independent study under a faculty member's direction. Student must document School of Engineering content via a written report. May be repeated for credit as topics vary (6 semester credit hours maximum). Instructor consent required. ([1-6]-0) R

BMEN 4V98 Engineering Practicum (1-6 semester credit hours) This course may be used as an honors course. Student must document School of Engineering content via a written report. May be repeated for credit as topics vary (6 semester credit hours maximum). Instructor consent required.

([1-6]-0) R

Computer Engineering

CE 1100 Introduction to Electrical and Computer Engineering (1 semester credit hour) Introduction to discipline and practice of Electrical and Computer Engineering. Basic study, problem solving, and other skills needed to succeed as an EE or CE major including an introduction to laboratory instruments and measurement techniques. Introduction to professional ethics, EE and CE engineering design and quantitative methods; team projects designed to replicate the decision process in real-world applications of the EE and CE engineering process. BMEN 1100 or CS 1200 or EE 1100 or MECH 1100 can substitute for this course. Credit cannot be received for more than one of the following: BMEN 1100 or CE 1100 or CS 1200 or EE 1100 or MECH 1100. (Same as EE 1100) (1-1) Y

CE 1202 Introduction to Electrical and Computer Engineering II (2 semester credit 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 UT Dallas, 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. Lab fee of $30 required. Prerequisite: CE 1100. (Same as EE 1202) (1.5-3) S

CE 1337 (COSC 1337) Computer Science I (3 semester credit hours) Review of control structures and data types with emphasis on structured data types. Applies the object-oriented programming paradigm, focusing on the definition and use of classes along with the fundamentals of object-oriented design. Includes basic analysis of algorithms, searching and sorting techniques, and an introduction to software engineering. Programming language of choice is C/C++. Students will also be registered for an exam section. Prerequisite: CS 1336 with a grade of C or better or equivalent. (Same as CS 1337) (3-0) S

CE 2305 (MATH 2305) Discrete Mathematics for Computing I (3 semester credit hours) Principles of counting. Boolean operations. Logic and proof methods. Recurrence relations. Sets, relations, functions. Elementary graph theory. Elementary number theory. Prerequisite: ALEKS score required or MATH 2312 with a grade of C or better or (Data Science major and MATH 2413). (Same as CS 2305) (3-0) S

CE 2310 Introduction to Digital Systems (3 semester credit 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 credit hours) Further applications of programming techniques, introducing the fundamental concepts of data structures and algorithms. Topics include recursion, fundamental data structures (including stacks, queues, linked lists, hash tables, trees, and graphs), and algorithmic analysis. Includes comprehensive programming projects. Programming language of choice is Java. Credit cannot be received for both CS 2337 and (CS 2336 or CE 2336). Prerequisite: (CE 1337 or CS 1337) with a grade of C or better. Prerequisite or Corequisite: (CE 2305 or CS 2305) with a grade of C or better or (Data Science major and MATH 3315). (Same as CS 2336) (3-0) S

CE 3161 Social Issues and Ethics in Engineering (1 semester credit hour) This course exposes students to major theoretical frameworks and principles of ethics to recognize and analyze a range of social and professional issues faced by engineers. Issues of personal and professional ethics, computer security and reliability, privacy, intellectual property, the balance between risk and benefits are examined using real and hypothetical cases with emphasis on formulating arguments that support informed judgments. Prerequisite or Corequisite: CE 2310 or EE 2310. Prerequisite: Junior level standing. (Same as EE 3161) (1-0) S

CE 3201 Electrical and Computer Engineering Fundamentals-I Laboratory (2 semester credit hours) Introduction to the fundamental building blocks of laboratory measurements and data analysis in Electrical and Computer Engineering. Lab fee of $30 required. Prerequisites: (CE 1202 or EE 1202) and RHET 1302. Prerequisite or Corequisite: (EE 3301 or CE 3301) and (EE 3320 or CE 3320). (Same as EE 3201) (1-3) S

CE 3202 Electrical and Computer Engineering Fundamentals-II Laboratory (2 semester credit hours) Introduction to more advanced building blocks of laboratory measurements and data analysis in Electrical and Computer Engineering. Lab fee of $30 required. Prerequisite: CE 3201 or EE 3201. Corequisite: ECS 3390. Prerequisite or Corequisite: EE 3310 or CE 3310. (Same as EE 3202) (1-3) S

CE 3301 Electrical Network Analysis (3 semester credit 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. (Same as EE 3301) (3-0) S

CE 3303 Discrete-Time Signals and Systems (3 semester credit hours) Students learn the fundamentals of discrete-time signals and systems. Complex numbers, sampling and analog to digital signal conversion, digital signals and discrete-time linear time-invariant systems, linear difference equations, convolution, z-transform and transfer function, discrete-time Fourier transform, discrete Fourier transform, fast Fourier transform, digital images and two-dimensional discrete Fourier transform. Credit cannot be received for more than one of the following: BMEN 3302 or BMEN 3402 or CE 3303 or EE 3302. Credit cannot be received for both CE 3303 and EE 4361. Prerequisite: MATH 2420. (3-0) S

CE 3310 Electronic Devices (3 semester credit 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. Prerequisites: MATH 2420 and PHYS 2326. (Same as EE 3310) (3-0) S

CE 3311 Electronic Circuits (3 semester credit 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 3301 or EE 3301. (Same as EE 3311) (3-0) S

CE 3320 Digital Circuits (3 semester credit 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. Credit cannot be received for both courses, CS 4341 and CE 3320. Prerequisite: CE 2310 or EE 2310. (Same as EE 3320) (3-0) S

CE 3345 Data Structures and Introduction to Algorithmic Analysis (3 semester credit 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. Prerequisites: ((CE 2305 or CS 2305) with a grade of C or better or (Data Science major and MATH 3315)) and (CE 2336 or CS 2336 or CS 2337) with a grade of C or better. Prerequisite or Corequisite: (CS 3341 or SE 3341 or ENGR 3341) or (Data Science major and STAT 3355). (Same as CS 3345 and SE 3345) (3-0) S

CE 3354 Software Engineering (3 semester credit 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 CS 2337) with a grade of C or better or CS 3333) and (CE 2305 or CS 2305) with a grade of C or better or equivalent. Prerequisite or Corequisite: ECS 3390. (Same as CS 3354 and SE 3354) (3-0) S

CE 4201 Electrical and Computer Engineering Laboratory in Computing Systems and Computer Engineering (2 semester credit hours) Laboratory topics in Computing Systems and Computer Engineering. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. (Same as EE 4201) (1-3) S

CE 4202 Electrical and Computer Engineering Laboratory in Circuits (2 semester credit hours) Laboratory topics in Circuits. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. (Same as EE 4202) (1-3) S

CE 4203 Electrical and Computer Engineering Laboratory in Signals and Systems (2 semester credit hours) Laboratory topics in Signals and Systems. Lab fee of $30 required. Prerequisite: CE 3202 or

EE 3202. Corequisite: CE 3303. (Same as EE 4203) (1-3) S

CE 4204 Electrical and Computer Engineering Laboratory in Devices (2 semester credit hours) Laboratory topics in Devices. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. (Same as EE 4204) (1-3) S

CE 4205 Electrical and Computer Engineering Laboratory in Power Electronics and Energy Systems (2 semester credit hours) Laboratory topics in Power Electronics and Energy Systems. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. (Same as EE 4205) (1-3) S

CE 4304 Computer Architecture (3 semester credit 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. Credit cannot be received for both courses, (CS 2340 or SE 2340) and (CE 4304 or EE 4304). Prerequisite: CE 3320 or EE 3320. (Same as EE 4304) (3-0) S

CE 4331 Applied Machine Learning (3 semester credit hours) Introduction to machine learning; supervised and unsupervised learning models; neural network and deep neural network learning models; work-flow; performance measures; implementation strategies for machine learning, social impacts and ethics of machine learning. Prerequisites: (MATH 2414 or MATH 2417) and ENGR 2300 and ENGR 3341. (Same as EE 4331) (3-0) S

CE 4337 Programming Language Paradigms (3 semester credit 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 different programming languages. Language-based security. Design, implement, and debug programs in various programming language paradigms. Prerequisites: ((CE 2336 or CS 2336 or CS 2337) with a grade of C or better or CS 3333) and (CE 2305 or CS 2305) with a grade of C or better and (CS 2340 or SE 2340 or CE 4304 or EE 4304). (Same as CS 4337) (3-0) S

CE 4348 Operating Systems Concepts (3 semester credit hours) An introduction to fundamental concepts in operating systems and how they are realized in a practical operating system such as UNIX. 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 2340 or SE 2340 or equivalent), and (CE 3345 or CS 3345 or SE 3345), and a working knowledge of C and UNIX. (3-0) S

CE 4370 Embedded Systems (3 semester credit hours) An introduction to micro-controllers and their uses. Features commonly found in a micro-controller are discussed, such as: The CPU structure which includes the Program Counter, Stack, Status Register, General Purpose Registers, ALU, Instruction Set. Peripheral devices including general purpose IOs (GPIOs), serial synchronous (e.g. SPI and I2C) and asynchronous communication (UART) interfaces. Different types of Analog to

Digital converters (ADC) and Memories (SRAM, DRAM, EPROM, EEPROM). ANSI-C programing language is used to create the binary machine code necessary to program a micro-controller system. Lab fee of $30 required. Prerequisite: CE 3320 or EE 3320. (Same as EE 4370) (3-1) Y

CE 4388 Senior Design Project I (3 semester credit 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. Prerequisites: ECS 3390 and CE 3161 and CE 3202 and CE 3303 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) and (CE 3354 or CS 3354 or SE 3354)) or (ENGR 3300 and EE 3302 and (CE 3311 or EE 3311) and (CE 3320 or EE 3320)) or (ENGR 3300 and EE 3302 and (CE 3345 or CS 3345 or SE 3345)). (Same as EE 4388) (3-0) S

CE 4389 Senior Design Project II (3 semester credit 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. (Same as EE 4389) (3-0) S

CE 4390 Computer Networks (3 semester credit 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. Credit cannot be received for both courses, (CE 4390 or CS 4390) and EE 4390. Prerequisite: (CE 3345 or CS 3345 or SE 3345) or equivalent. (Same as CS 4390) (3-0) S

CE 4399 Senior Honors in Computer Engineering (3 semester credit hours) For students conducting independent research for honors theses or projects. Additional prerequisites may be required depending on the specific course topic. (0-3) R

CE 4V95 Undergraduate Topics in Computer Engineering (1-9 semester credit hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. ([1-9]-0) R

CE 4V97 Independent Study in Computer Engineering (1-9 semester credit hours) Independent study under a faculty member's direction. May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-9]-0) R

CE 4V98 Undergraduate Research in Computer Engineering (1-9 semester credit hours) Topics will vary from semester to semester. May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-9]-0) R

Computer Science

CS 1134 Computer Science Laboratory (1 semester credit hour) Laboratory course to accompany CS 1334. This course assists students in experiencing elementary programming in a high-level language. May not be used to satisfy degree requirements for majors in the School of Engineering and Computer Science. Credit cannot be received for both courses, CS 1134 and CS 1136. Lab fee of $30 required. Corequisite: CS 1334. (0-3) S

CS 1136 Computer Science Laboratory (1 semester credit hour) Laboratory course to accompany CS 1336. This course assists students in experiencing elementary programming in a high-level language. Lab fee of $30 required. Corequisite: CS 1336. (0-3) S

CS 1200 Introduction to Computer Science and Software Engineering (2 semester credit hours) Introduction to the computing professions; overview of Computer Science (CS) and Software Engineering (SE) curricula, connections with Computer Engineering, other Engineering and Computer Science fields, and Arts and Technology programs; problem solving and other skills needed to succeed as a CS or SE major. Introduction to quantitative methods; team projects designed to replicate decision processes and problem solving in real-world situations; additional preparatory topics for CS and SE majors. BMEN 1100 or CE 1100 or EE 1100 or MECH 1100 can substitute for this course (together with 1 hour of CS elective). Credit cannot be received for more than one of the following: BMEN 1100 or CE 1100 or CS 1200 or EE 1100 or MECH 1100. (2-0) Y

CS 1324 Introduction to Programming for Biomedical Engineers (3 semester credit hours) Computer programming in a high-level, block structured language with a focus on engineering applications in medicine. Basic data types and variables, memory usage, control structures, functions/procedures and parameter passing, recursion, input/output. Programming projects related to biomedical engineering applications. May not be used to satisfy degree requirements for majors in Computer Engineering, Computer Science, and Software Engineering. Prerequisite: CS 1336 or equivalent. (3-0) S

CS 1325 Introduction to Programming (3 semester credit 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 assignments related to engineering applications, numerical methods. May not be used to satisfy degree requirements for majors in Computer Engineering, Computer Science, and Software Engineering. Prerequisite or Corequisite: MATH 2413 or MATH 2417 (3-0) S

CS 1334 Programming Fundamentals for Non-Majors (3 semester credit 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. May not be used to satisfy degree requirements for majors in the School of Engineering and Computer Science. Credit cannot be received for both courses, CS 1334 and CS 1336. Note that a grade of C or better is required in order to register for CS 1335. Corequisite: CS 1134. (3-0) S

CS 1335 Computer Science I for Non-majors (3 semester credit 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. May not be used to satisfy degree requirements for majors in the School of Engineering and Computer Science, especially majors in Computer Science and Engineering. Credit cannot be received for both courses, CS 1335 and (CE 1337 or CS 1337). Prerequisite: CS 1334 with a grade of C or better or equivalent. (3-0) S

CS 1336 (COSC 1336) Programming Fundamentals (3 semester credit hours) Introduces the fundamental concepts of structured programming. Topics include software development methodology, data types, control structures, functions, arrays, and the mechanics of running, testing, and debugging. Programming language of choice is C. The class is open to students in the School of Engineering and Computer Science only. Note that a grade of C- or better in this class is required in order to register for (CS 1324 or CS 1325); a grade of C or better in this class is required to register for (CE 1337 or CS 1337). Corequisite: CS 1136. (3-0) S

CS 1337 (COSC 1337) Computer Science I (3 semester credit hours) Review of control structures and data types with emphasis on structured data types. Applies the object-oriented programming paradigm, focusing on the definition and use of classes along with the fundamentals of object-oriented design. Includes basic analysis of algorithms, searching and sorting techniques, and an introduction to software engineering. Programming language of choice is C/C++. Students will also be registered for an exam section. Prerequisite: CS 1336 with a grade of C or better or equivalent. (Same as CE 1337) (3-0) S

CS 2305 (MATH 2305) Discrete Mathematics for Computing I (3 semester credit hours) Principles of counting. Boolean operations. Logic and proof methods. Recurrence relations. Sets, relations, functions. Elementary graph theory. Elementary number theory. Prerequisite: ALEKS score required or MATH 2312 with a grade of C or better or (Data Science major and MATH 2413). (Same as CE 2305) (3-0) S

CS 2335 Computer Science II for Non-majors (3 semester credit 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. May not be used to satisfy degree requirements for majors in the School of Engineering and Computer Science. Credit cannot be received for both courses, CS 2335 and (CE 2336 or CS 2336 or CS 2337). Prerequisite: CS 1335 or CE 1337 or CS 1337. (3-0) S

CS 2336 (COSC 2336) Computer Science II (3 semester credit hours) Further applications of programming techniques, introducing the fundamental concepts of data structures and algorithms. Topics include recursion, fundamental data structures (including stacks, queues, linked lists, hash tables, trees, and graphs), and algorithmic analysis. Includes comprehensive programming projects. Programming language of choice is Java. Credit cannot be received for both CS 2337 and (CS 2336 or CE 2336). Prerequisite: (CE 1337 or CS 1337) with a grade of C or better. Prerequisite or Corequisite: (CE 2305 or CS 2305) with a grade of C or better or (Data Science major and MATH 3315). (Same as CE 2336) (3-0) S

CS 2337 Computer Science II (3 semester credit hours) Further applications of programming techniques, introducing the fundamental concepts of data structures and algorithms. Topics include recursion, fundamental data structures (including stacks, queues, linked lists, hash tables, trees, and graphs), and algorithmic analysis. Includes comprehensive programming projects. Programming language of choice is C++. Credit cannot be received for both CS 2337 and (CS 2336 or CE 2336). Prerequisite: AP score of at least 4. Prerequisite or Corequisite: (CE 2305 or CS 2305) with a grade of C or better or (Data Science major and MATH 3315). (3-0) S

CS 2340 Computer Architecture (3 semester credit 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. Credit cannot be received for both courses, (CS 2340 or SE 2340) and (CE 4304 or EE 4304). Prerequisites: (CE 1337 or CS 1337) with a grade of C or better or equivalent and (CE 2305 or CS 2305) with a grade of C or better. (Same as SE 2340) (3-0) S

CS 2V95 Individual Instruction in Computer Science (1-6 semester credit hours) Individual study under a faculty member's direction. May be repeated for credit as topics vary (6 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-6]-0) R

CS 3149 Competitive Learning in Computer Science (1 semester credit 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 as topics vary (3 semester credit hours maximum). Prerequisites: (CE 2336 or CS 2336 or CS 2337) with a grade of C or better and CS 3305 with a grade of C or better. (1-0) Y

CS 3162 Professional Responsibility in Computer Science and Software Engineering (1 semester credit hour) Professional and ethical responsibilities of computer scientists and software engineers as influenced by growth in computer use and networks. Costs and benefits of computer technology. Risks and liabilities of safety-critical systems. Social implications of the Internet. Interaction between human values and technical decisions involving computing. Intellectual Property. Global impact of computing. Prerequisites or Corequisites: CS 3345 and CS 3354. (Same as SE 3162) (1-0) S

CS 3305 Discrete Mathematics for Computing II (3 semester credit 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. Credit cannot be received for both courses, CS 3305 and SE 3306. Double majors are required to take CS 3305. Prerequisites: (CE 2305 or CS 2305) with a grade of C or better, and (MATH 2414 or MATH 2419). (3-0) S

CS 3333 Data Structures (3 semester credit 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. May not be used to satisfy degree requirements for majors in Computer Science. Credit cannot be received for both courses, (CE 2336 or CS 2336 or CS 2337) and CS 3333. Prerequisite: CS 1335 or (CE 1337 or CS 1337) or equivalent programming experience. (3-0) Y

CS 3341 Probability and Statistics in Computer Science and Software Engineering (3 semester credit 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. Credit cannot be received for both courses, (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) with a grade of C or better. (Same as SE 3341 and STAT 3341) (3-0) S

CS 3345 Data Structures and Introduction to Algorithmic Analysis (3 semester credit 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. Prerequisites: ((CE 2305 or CS 2305) with a grade of C or better or (Data Science major and MATH 3315)) and (CE 2336 or CS 2336 or CS 2337) with a grade of C or better. Prerequisite or Corequisite: (CS 3341 or SE 3341 or ENGR 3341) or (Data Science major and STAT 3355). (Same as CE 3345 and SE 3345) (3-0) S

CS 3354 Software Engineering (3 semester credit 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 CS 2337) with a grade of C or better or CS 3333) and (CE 2305 or CS 2305) with a grade of C or better 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 credit 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. May not be used to satisfy degree requirements for majors in the School of Engineering and Computer Science. Prerequisite: CS 2335. (3-0) Y

CS 3377 Systems Programming in UNIX and Other Environments (3 semester credit hours) Basic UNIX concepts, commands and utilities, organization of UNIX file system including links and access control, creating and managing UNIX processes and threads, implementing algorithms using shell scripts, basic networking concepts including socket and client-server programming, inter-process communication using pipes and signals, using a version control system to manage work, and introduction to cloud computing. Design and implementation of a comprehensive programming project is required. Prerequisite: (CE 2336 or CS 2336 or CS 2337) with a grade of C or better or equivalent. (Same as SE 3377) (3-0) S

CS 3385 Ethics, Law, Society, and Computing (3 semester credit 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 credit hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-9]-0) S

CS 4141 Digital Systems Laboratory (1 semester credit 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. Lab fee of $30 required. Corequisite: CS 4341. (0-3) S

CS 4301 Special Topics in Computer Science (3 semester credit hours) May be repeated for credit as topics vary (9 semester credit hours maximum). Prerequisite: CE 3345 or CS 3345 or SE 3345. (3-0) S

CS 4314 Intelligent Systems Analysis (3 semester credit hours) This advanced machine learning course covers mathematics essential for the analysis and design covers mathematics essential for the analysis and design of unsupervised, supervised, and reinforcement machine learning algorithms including deep learning neural network models formulated within a statistical empirical risk minimization framework. Course topics include: advanced vector and matrix calculus and stochastic sequences of mixed random vectors and Bayesian nets. Unsupervised, supervised and reinforcement machine learning applications are emphasized through the course. Prerequisites: ((MATH 2414 or MATH 2419) and (CS 3341 or SE 3341) and MATH2418) or instructor consent required. (Same as CGS 4314) (3-0) T

CS 4315 Intelligent Systems Design (3 semester credit hours) This advanced machine learning course covers mathematics essential for the analysis and design of unsupervised, supervised, and reinforcement machine learning algorithms including deep learning neural network models formulated within a statistical empirical risk minimization framework. Topics include: convergence analysis of adaptive and batch learning algorithms, Bayes Nets and Marko fields, Monte Carlo Markov Chain inference algorithms, bootstrap sampling methods, and the statistical analysis of generalization performance. Unsupervised, supervised, and reinforcement machine learning applications are emphasized throughout the course. Prerequisite: CGS 4314 or CS 4314. (Same as CGS 4315) (3-0) T

CS 4332 Introduction to Programming Video Games (3 semester credit 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. (3-0) Y

CS 4334 Numerical Analysis (3 semester credit 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. Prerequisites: (MATH 2370 or CS 1324 or CS 1325 or CE 1337 or CS 1337) and (MATH 2418 and MATH 2451 or MATH 3351). (Same as MATH 4334) (3-0) Y

CS 4336 Advanced Java (3 semester credit hours) Advanced Java programming techniques for enterprise application development. Covers Java Enterprise API's for working with databases, web servers, and application servers. Students will create multi-tiered web applications and web services integrated with a database. Prerequisite: (CE 2336 or CS 2336 or CS 2337) or equivalent. (3-0) T

CS 4337 Programming Language Paradigms (3 semester credit 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 different programming languages. Language-based security. Design, implement, and debug programs in various programming language paradigms. Prerequisites: ((CE 2336 or CS 2336 or CS 2337) with a grade of C or better or CS 3333) and (CE 2305 or CS 2305) with a grade of C or better and (CS 2340 or SE 2340 or CE 4304 or EE 4304). (Same as CE 4337) (3-0) S

CS 4341 Digital Logic and Computer Design (3 semester credit 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. Credit cannot be received for both courses, CS 4341 and (CE 3320 or EE 3320). Prerequisites: (CE 2310 or EE 2310) or (CS 2340 or SE 2340) and PHYS 2326. Corequisite: CS 4141. (3-0) S

CS 4347 Database Systems (3 semester credit 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. (Same as SE 4347) (3-0) Y

CS 4348 Operating Systems Concepts (3 semester credit 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 2340 or SE 2340) or equivalent and (CS 3377 or SE 3377) and (CE 3345 or CS 3345 or SE 3345). (Same as SE 4348) (3-0) S

CS 4349 Advanced Algorithm Design and Analysis (3 semester credit hours) Asymptomatic 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 with a grade of C or better, and (CE 3345 or CS 3345 or SE 3345). (3-0) S

CS 4352 Human-Computer Interaction I (3 semester credit hours) Broad overview of how human-computer interaction (HCI) informs the user-centered design (UCD) process. Practical experience in the core methods of user experience design and research throughout the product development cycle. (Same as CGS 4352) (3-0) Y

CS 4353 Human-Computer Interaction II (3 semester credit hours) Exploration of advanced topics in human-computer interaction (HCI) in both research and industry. Practical experience with latent methods in user experience (UX) design and research that build upon core methods introduced in CS 4352. Typically used in the design of usable systems. Prerequisite: CGS 4352 or CS 4352. (Same as CGS 4353) (3-0) Y

CS 4361 Computer Graphics (3 semester credit 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 CS 2337) and (CE 3345 or CS 3345 or SE 3345) or equivalent. (3-0) Y

CS 4365 Artificial Intelligence (3 semester credit 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 equivalent. (3-0) Y

CS 4371 Introduction to Big Data Management and Analytics (3 semester credit hours) This course focuses on scalable data management and mining algorithms for analyzing very large amounts of data (i.e., Big Data). Included topics are: Mapreduce, NoSQL systems (e.g., key-value stores, column-oriented data stores, stream processing systems), association rule mining, large scale supervised and unsupervised learning, and applications including recommendation systems, web and big data security. Prerequisites: (CS 2336 or CS 2337) and CS 4347. (3-0) Y

CS 4372 Computational Methods for Data Scientists (3 semester credit hours) This course will focus on the application of computational tools to solve machine learning problems. Applicable languages may include Python, 'R', Weka, or others at the discretion of the instructor. Students will use these languages to apply machine learning concepts to problem data sets. Corequisite: CS 4375. (3-0) Y

CS 4375 Introduction to Machine Learning (3 semester credit 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 or (Data Science major and STAT 3355)) and (CE 3345 or CS 3345 or SE 3345) or equivalent. (3-0) Y

CS 4376 Object-Oriented Design (3 semester credit 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. Prerequisites: (CE 2336 or CS 2336 or CS 2337) with a grade of C or better or equivalent and (CE 3354 or CS 3354 or SE 3354). (Same as SE 4376) (3-0) S

CS 4384 Automata Theory (3 semester credit hours) A review of the abstract notions encountered in machine computation. Deterministic and nondeterministic finite automata; regular expressions, regular sets, context-free grammars, pushdown automata, context-free languages. Selected topics from Turing Machines and undecidability. Prerequisite: CS 3305 with a grade of C or better. (3-0) S

CS 4386 Compiler Design (3 semester credit 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 equivalent. (3-0) R

CS 4389 Data and Applications Security (3 semester credit 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 credit 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. Credit cannot be received for both courses, (CE 4390 or CS 4390) and EE 4390. Prerequisite: (CE 3345 or CS 3345 or SE 3345) or equivalent. (Same as CE 4390) (3-0) S

CS 4391 Introduction to Computer Vision (3 semester credit 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 equivalent. (3-0) Y

CS 4392 Computer Animation (3 semester credit 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 equivalent. (3-0) Y

CS 4393 Computer and Network Security (3 semester credit 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 equivalent. (3-0) Y

CS 4394 Implementation of Modern Operating Systems (3 semester credit 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. Prerequisite: CE 4348 or CS 4348 or SE 4348 or equivalent programming experience. (3-0) R

CS 4395 Human Language Technologies (3 semester credit 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. Prerequisites: (CS 3341 or SE 3341) and (CE 3345 or CS 3345 or SE 3345) or equivalent. (3-0) Y

CS 4396 Networking Laboratory (3 semester credit 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. Prerequisite: CS 4390 or equivalent. (3-0) Y

CS 4397 Embedded Computer Systems (3 semester credit 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 equivalent. (3-0) Y

CS 4398 Digital Forensics (3 semester credit 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) and (CE 4390 or CS 4390) or equivalent. (3-0) Y

CS 4399 Senior Honors in Computer Science (3 semester credit hours) For students conducting independent research for honors theses or projects. Topics may vary. Additional prerequisites may be required depending on the specific course topic. Instructor consent required. (3-0) R

CS 4475 Capstone Project (4 semester credit hours) This course is intended to provide hands-on experience in a data science project. Students will work in teams on projects and will be involved in formulating a relevant problem, collecting the requisite data, finding a solution, and developing the necessary computational tools. The deliverables will include a final project report that details these steps and presentation of the project. Prerequisites: STAT 4355 and CS 4375. (Same as MATH 4475 and STAT 4475) (4-0) Y

CS 4485 Computer Science Project (4 semester credit 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), 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 credit hours) Subject matter will vary from semester to semester. Additional prerequisites may be required depending on the specific course topic. May be used as CS Guided Elective on CS degree plans. May be repeated for credit as topics vary (9 semester credit hours maximum). Prerequisites: (CS 3345 or SE 3345 or CE 3345) and instructor consent required. ([1-9]-0) R

CS 4V98 Undergraduate Research in Computer Science (1-9 semester credit hours) Topics will vary from semester to semester. May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-9]-0) R

Engineering and Computer Science

ECS 1100 Introduction to Engineering and Computer Science (1 semester credit hour) Introduction to engineering and computing careers; overview of Engineering and Computer Science (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. Corequisite: UNIV 1010. (1-1) Y

ECS 2361 Social Issues and Ethics in Science and Technology (3 semester credit hours) This course exposes students to major theoretical approaches and professional codes of ethics and how they may be applied to explore a range of important social issues in the information age. 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 case studies. Prerequisite: Completion of an 030 core course. (3-0) Y

ECS 3301 Introduction to Nanoscience and Nanotechnology (3 semester credit 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 and (MATH 2415 or MATH 2419 or equivalent) and PHYS 2326 or instructor consent required. (Same as MSEN 3301) (3-0) Y

ECS 3310 Introduction to Materials Science (3 semester credit 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. Credit cannot be received for both MECH 3360 and (ECS 3310 or MSEN 3310). Prerequisites: CHEM 1311 and (MATH 2415 or MATH 2419 or equivalent) and PHYS 2326 or instructor consent required. (Same as MSEN 3310) (3-0) Y

ECS 3390 Professional and Technical Communication (3 semester credit 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 credit 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 for credit as topics vary (6 semester credit hours maximum). Instructor consent required. (1-0) Y

ECSC 3179 ENG IPP Assignment (1 semester credit 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 for credit as topics vary (6 semester credit hours maximum). Instructor consent required. (1-0) Y

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

ECSC 4378 Professional Industrial Practice Program (3 semester credit 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. May be repeated for credit as topics vary (6 semester credit hours maximum). Prerequisites or Corequisites: ECS 3390 and instructor consent required. (3-0) T

Electrical Engineering

EE 1100 Introduction to Electrical and Computer Engineering (1 semester credit hour) Introduction to discipline and practice of Electrical and Computer Engineering. Basic study, problem solving, and other skills needed to succeed as an EE or CE major including an introduction to laboratory instruments and measurement techniques. Introduction to professional ethics, EE and CE engineering design and quantitative methods; team projects designed to replicate the decision process in real-world applications of the EE and CE engineering process. BMEN 1100 or CE 1100 or CS 1200 or MECH 1100 can substitute for this course. Credit cannot be received for more than one of the following: BMEN 1100 or CE 1100 or CS 1200 or EE 1100 or MECH 1100. (Same as CE 1100) (1-1) Y

EE 1202 Introduction to Electrical and Computer Engineering II (2 semester credit 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 UT Dallas, 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. Lab fee of $30 required. Prerequisite: EE 1100. (Same as CE 1202) (1.5-3) S

EE 2310 Introduction to Digital Systems (3 semester credit 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 3161 Social Issues and Ethics in Engineering (1 semester credit hour) This course exposes students to major theoretical frameworks and principles of ethics to recognize and analyze a range of social and professional issues faced by engineers. Issues of personal and professional ethics, computer security and reliability, privacy, intellectual property, the balance between risk and benefits are examined using real and hypothetical cases with emphasis on formulating arguments that support informed judgments. Prerequisite or Corequisite: CE 2310 or EE 2310. Prerequisite: Junior level standing. (Same as CE 3161) (1-0) S

EE 3201 Electrical and Computer Engineering Fundamentals-I Laboratory (2 semester credit hours) Introduction to the fundamental building blocks of laboratory measurements and data analysis in Electrical and Computer Engineering. Lab fee of $30 required. Prerequisites: (CE 1202 or EE 1202) and RHET 1302. Prerequisite or Corequisite: (EE 3301 or CE 3301) and (EE 3320 or CE 3320). (Same as CE 3201) (1-3) S

EE 3202 Electrical and Computer Engineering Fundamentals-II Laboratory (2 semester credit hours) Introduction to more advanced building blocks of laboratory measurements and data analysis in Electrical and Computer Engineering. Lab fee of $30 required. Prerequisite: CE 3201 or EE 3201. Corequisite: ECS 3390. Prerequisite or Corequisite: EE 3310 or CE 3310. (Same as CE 3202) (1-3) S

EE 3301 Electrical Network Analysis (3 semester credit 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. (Same as CE 3301) (3-0) S

EE 3302 Signals and Systems (3 semester credit 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. Credit cannot be received for more than one of the following: BMEN 3302 or BMEN 3402 or CE 3303 or EE 3302. Prerequisite: ENGR 3300. (3-0) S

EE 3310 Electronic Devices (3 semester credit 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. Prerequisites: MATH 2420 and PHYS 2326. (Same as CE 3310) (3-0) S

EE 3311 Electronic Circuits (3 semester credit 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 3301 or EE

3301. (Same as CE 3311) (3-0) S

EE 3320 Digital Circuits (3 semester credit 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. Credit cannot be received for both courses, CS 4341 and EE 3320. Prerequisite: CE 2310 or EE 2310. (Same as CE 3320) (3-0) S

EE 3350 Communications Systems (3 semester credit 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) and EE 3302 and ENGR 3341. (3-0) S

EE 4168 RF/Microwave Laboratory (1 semester credit 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. Lab fee of $30 required. Prerequisite or Corequisite: EE 4368. (0-1) T

EE 4201 Electrical and Computer Engineering Laboratory in Computing Systems and Computer Engineering (2 semester credit hours) Laboratory topics in Computing Systems and Computer Engineering. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. (Same as CE 4201) (1-3) S

EE 4202 Electrical and Computer Engineering Laboratory in Circuits (2 semester credit hours) Laboratory topics in Circuits. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. (Same as CE 4202) (1-3) S

EE 4203 Electrical and Computer Engineering Laboratory in Signals and Systems (2 semester credit hours) Laboratory topics in Signals and Systems. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. Corequisite: EE 3302. (Same as CE 4203) (1-3) S

EE 4204 Electrical and Computer Engineering Laboratory in Devices (2 semester credit hours) Laboratory topics in Devices. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. (Same as CE 4204) (1-3) S

EE 4205 Electrical and Computer Engineering Laboratory in Power Electronics and Energy Systems (2 semester credit hours) Laboratory topics in Power Electronics and Energy Systems. Lab fee of $30 required. Prerequisite: CE 3202 or EE 3202. (Same as CE 4205) (1-3) S

EE 4301 Electromagnetic Engineering I (3 semester credit 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). (3-0) S

EE 4304 Computer Architecture (3 semester credit 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. Credit cannot be received for both courses, (CS 2340 or SE 2340) and (CE 4304 or EE 4304). Prerequisite: CE 3320 or EE 3320. (Same as CE 4304) (3-0) S

EE 4310 Systems and Controls (3 semester credit 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 EE 3302. (3-0) S

EE 4325 Introduction to VLSI Design (3 semester credit 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 credit 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 3310 or EE 3310. (3-0) S

EE 4331 Applied Machine Learning (3 semester credit hours) Introduction to machine learning; supervised and unsupervised learning models; neural network and deep neural network learning models; work-flow; performance measures; implementation strategies for machine learning, social impacts and ethics of machine learning. Prerequisites: (MATH 2414 or MATH 2417) and ENGR 2300 and ENGR 3341. (Same as CE 4331) (3-0) S

EE 4340 Analog Integrated Circuit Analysis and Design (3 semester credit 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) S

EE 4342 Introduction to Robotics (3 semester credit hours) Fundamentals of robotics, rigid motions, homogeneous transformations, forward and inverse kinematics, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Lab fee of $30 required. Prerequisite or Corequisite: BMEN 4310 or EE 4310 or MECH 4310 or equivalent. (Same as BMEN

4342 and MECH 4342) (2-3) Y

EE 4360 Digital Communications (3 semester credit 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. Prerequisites: ENGR 3341 and EE 3302. (3-0) T

EE 4361 Introduction to Digital Signal Processing (3 semester credit 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: EE 3302. (3-0) T

EE 4362 Introduction to Energy Conversion (3 semester credit hours) Single phase and three phase electrical system; Real, Reactive, Apparent, and Complex powers, Power factor; Generation of three phase voltages, Star and Delta connections, Power calculations and measurements; Transformers: Theory of operation, voltage and current ratios, transformer ratings, three phase transformers; Electric Machines: DC, Induction, and Synchronous Machines - Characteristics, analysis and operation; Introduction to Renewable Energy Systems: Solar and Wind Energy Systems. Prerequisite: EE 3301. (3-0) R

EE 4363 Introduction to Power Electronics (3 semester credit hours) Power Electronic devices operation and characteristics - Thyristor, Power MOSFET, IGBT, and other devices. Rectifiers and controlled rectifiers operation and control. DC-DC converters - buck and boost converters. Inverters and PWM operation. Switching mode power supplies. Prerequisite: EE 3301 (3-0) Y

EE 4365 Introduction to Wireless Communication (3 semester credit 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. Prerequisites: EE 3302 and ENGR 3341. (3-0) Y

EE 4367 Telecommunication Networks (3 semester credit 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 3302 or CE 3303. (3-0) Y

EE 4368 RF Circuit Design Principles (3 semester credit 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) S

EE 4370 Embedded Systems (3 semester credit hours) An introduction to micro-controllers and their uses. Features commonly found in a micro-controller are discussed, such as: The CPU structure which includes the Program Counter, Stack, Status Register, General Purpose Registers, ALU, Instruction Set. Peripheral devices including general purpose IOs (GPIOs), serial synchronous (e.g. SPI and I2C) and asynchronous communication (UART) interfaces. Different types of Analog to Digital converters (ADC) and Memories (SRAM, DRAM, EPROM, EEPROM). ANSI-C programing language is used to create the binary machine code necessary to program a micro-controller system. Lab fee of $30 required. Prerequisite: CE 3320 or EE 3320. (Same as CE 4370) (3-3) Y

EE 4371 Introduction to MEMS (3 semester credit hours) The goal of this course is to provide an introduction to M/NEMS fabrication techniques, selected device applications, and the design tradeoffs in developing systems. Prerequisites: (MECH 3310 and MECH 3350 and PHYS 2126 and PHYS 2326) or (CE 3310 or EE 3310). (Same as MECH 4370) (3-0) Y

EE 4388 Senior Design Project I (3 semester credit 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. Prerequisites: ECS 3390 and EE 3161 and EE 3202 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) and (CE 3354 or CS 3354 or SE 3354)) or (ENGR 3300 and EE 3302 and (CE 3311 or EE 3311) and (CE 3320 or EE 3320)) or (ENGR 3300 and EE 3302 and (CE 3345 or CS 3345 or SE 3345)). (Same as CE 4388) (3-0) S

EE 4389 Senior Design Project II (3 semester credit 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. (Same as CE 4389) (3-0) S

EE 4391 Technology of Plasma (3 semester credit 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). Recommended: ENGR 3341. Prerequisites: ENGR 3300 and (CE 3310 or EE 3310). (Same as MSEN

4391) (3-0) T

EE 4399 Senior Honors in Electrical Engineering (3 semester credit hours) For students conducting independent research for honors theses or projects. May be repeated for credit as topics vary. Additional prerequisites may be required depending on the specific course topic. Instructor consent required. (3-0) R

EE 4V95 Undergraduate Topics in Electrical Engineering (1-9 semester credit hours) May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. ([1-9]-0) R

EE 4V97 Independent Study in Electrical Engineering (1-9 semester credit hours) Independent study under a faculty member's direction. May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-9]-0) R

EE 4V98 Undergraduate Research in Electrical Engineering (1-9 semester credit hours) This course may be used as an honors course. May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-9]-0) R

Engineering

ENGR 2300 Linear Algebra for Engineers (3 semester credit 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. Prerequisite or Corequisite: MATH 2414 or MATH 2419. (2-1) S

ENGR 3300 Advanced Engineering Mathematics (3 semester credit hours) Survey of advanced mathematics topics needed in the study of engineering. Topics include use of complex numbers, properties of complex-valued functions, scalar and vector fields, introduction to partial differential equations, and Fourier series. Examples are provided from electromagnetics, fluid mechanics, thermodynamics, and engineered systems. This course includes a required laboratory. Prerequisites: (MATH 2415 or MATH 2419 or equivalent) and ENGR 2300. Prerequisite or Corequisite: MATH 2420. (3-1) S

ENGR 3341 Probability Theory and Statistics (3 semester credit 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/pmfs for multiple random variables, moments, central limit theorem, elementary statistics, empirical distribution correlation. Credit cannot be received for both courses, (CS 3341 or SE 3341 or STAT 3341) and ENGR 3341. Recommended Corequisite: MATH 2420. Prerequisite: MATH 2414 or MATH 2419. (3-0) S

Engineering Projects in Community Service

EPCS 2100 Engineering Project in Community Service (1 semester credit hour) This is a design course in which multidisciplinary teams will solve engineering-based problems for the local community. Students will learn the complete design process, awareness of the customer in engineering design, active use of rapid prototyping tools, leadership and project management skills, communication skills, and more. This course will include lectures and instruction in UTDesign Studio. (1-1) S

EPCS 2200 Engineering Projects in Community Service (2 semester credit hours) This is a design course in which multidisciplinary teams solve engineering/computing-based problems for the local community. Students will learn the complete design process, awareness of the customer in engineering design, active use of rapid prototyping tools, leadership, communication skills, and more. (1-2) S

EPCS 3100 Engineering Project in Community Service II (1 semester credit hour) Design course in which multidisciplinary teams solve engineering-based problems benefiting service organizations and the local community. Students will refine the skills and knowledge gained in ECSC 2100, by continue working on projects from previous semesters, and lecture topics will focus on leadership and project management skills, communication skills, and more. This course will include lectures and instruction in UTDesign Studio. May be repeated for credit (3 semester credit hours maximum). Lab fee of $30 required. Prerequisite: EPCS 2100. (1-1) S

EPCS 3105 Engineering Projects in Community Service Abroad (1 semester credit hour) This is a study-abroad course in which students from multiple disciplines will learn human-centered design, understand customers' needs, understand how engineering design thinking can be used in combination with their disciplines to impact customers, and learn about the culture of the people/place they will travel to. The student's skills from their discipline and understanding of the people will be applied in a 2-week study abroad trip. (1-0) R

EPCS 3200 Engineering Projects in Community Service II (2 semester credit hours) Design course in which multidisciplinary teams solve engineering-based problems benefiting service organizations and the local community. Students will refine the skills and knowledge gained in ECSC 2200, by continuing to work on projects from previous semesters, and lecture topics will focus on leadership and project management skills, communication skills, and more. This course will include lectures and instruction in the UTDesign Studio. May be repeated for credit (6 semester credit hours maximum). Prerequisite: EPCS 2100 or EPCS 2200. (1-2) S

Interdisciplinary Studies-EE and CS

ISEC 4102 Computer Art Laboratory (1 semester credit hour) This course involves the creation and use of algorithms for art on microcomputers. Lab fee of $30 required. Corequisite: ISEC 4201. (0-2) R

ISEC 4201 The Computer and the Artist (2 semester credit 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. Corequisite: ISEC 4102. (2-0) R

ISEC 4395 Computing in Society (3 semester credit hours) Computing in society and business. The Internet. Information Technology: principles, practices, risks, and opportunities. Tour of a computer system. Software systems. The social context of computing. Careers in computing. Popular culture in the Digital Age. The risks of technology: ACM code of ethics, computer crime, system disasters. Human rights and privacy issues. Computers and education. (3-0) R

ISEC 4V87 Special Interdisciplinary Topics in Engineering or Computer Science (1-6 semester credit hours) May be repeated for credit as topics vary (9 semester credit hours maximum). Instructor consent required. ([1-6]-0) R

Mechanical Engineering

MECH 1100 Introduction to Mechanical Engineering I (1 semester credit hour) Introduction to professional ethics, engineering design and quantitative methods; team projects designed to replicate decision processes in real-world situations; additional preparatory topics for Mechanical Engineering. BMEN 1100 or CE 1100 or CS 1200 or EE 1100 can substitute for this course. Credit cannot be received for more than one of the following: BMEN 1100, CE 1100, CS 1200, EE 1100 or MECH 1100. (1-1) Y

MECH 1208 Introduction to Mechanical Engineering II (2 semester credit 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 projects, and lectures by mechanical engineering experts. Prerequisite: MECH 1100. 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 credit hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary. Additional prerequisites may be required depending on the specific course topic. (9 semester credit hours maximum). Instructor consent required. ([0-9]-[0-9]) R

MECH 2120 Mechanics of Materials Laboratory (1 semester credit hour) Laboratory course. The laboratory introduces techniques for measurements of mechanical properties and data analysis processes. Operation of materials test system to conduct experiments including tension, compression and bending to measure mechanical properties that include Young's modulus, yield strength, stress-strain curve, hardness, and impact energy absorption. Lab fee of $30 required. Corequisite: MECH 2320. (0-3) S

MECH 2310 (ENGR 2301) Statics (3 semester credit 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 2415 or MATH 2419 or equivalent. (3-0) S

MECH 2320 (ENGR 2332) Mechanics of Materials (3 semester credit hours) Lecture course. Introduction to stress and deformation analysis of basic structural elements subjected to axial, torsional, bending, and pressure loads. Prerequisites: (MATH 2415 or MATH 2419 or equivalent) and MECH 2310. Corequisite: MECH 2120. (3-0) S

MECH 2330 (ENGR 2302) Dynamics (3 semester credit 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 are presented. Single degree of freedom vibration systems and simulation tools are introduced. Prerequisite: MECH 2310. Prerequisites or Corequisites: ENGR 2300 and MATH 2420. (3-0) S

MECH 2340 Circuits and Applied Electronics (3 semester credit hours) Lecture/laboratory course. The purpose of this course is to give students a general understanding of basic concepts in electronics geared specifically toward application. Course topics include: circuit components and theory (resistors, capacitors, inductors, component networks), power concepts (AC, DC, single and 3-phase), basic microelectronics (semiconductors, diodes, transistors, op-amps, amplifiers), and digital design (number systems, logic circuits, common ICs). This course includes a laboratory component and a team-based final project. Prerequisites: MATH 2420 and PHYS 2326 and MECH 1208. (2-3) Y

MECH 2V95 Topics in Mechanical Engineering (1-9 semester credit hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([0-9]-[0-9]) R

MECH 3105 Computer Aided Design Laboratory (1 semester credit hour) Laboratory course associated with MECH 3305. Design activities involving CAD tools constitute a major portion of the course. Lab fee of $30 required. Corequisite: MECH 3305. (0-3) S

MECH 3115 Fluid Mechanics Laboratory (1 semester credit hour) Laboratory course associated with MECH 3315. Conduct experiments on various fluid mechanics principles including hydrostatics, pipe flows, aerodynamics, and turbulence. Students need to be able to interpret data using fluid mechanics theories and uncertainty analysis. Lab fee of $30 required. Prerequisite: MECH 3315; it is recommended that the laboratory is taken the next long semester after completion of MECH 3315. (0-3) S

MECH 3120 Heat Transfer Laboratory (1 semester credit 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. Lab fee of $30 required. Prerequisite: MECH 3320; it is recommended that the laboratory is taken the next long semester after completion of MECH 3320. (0-3) S

MECH 3150 Kinematics and Dynamics Laboratory (1 semester credit hour) Laboratory course associated with MECH 3350. Course focuses on performing a team design project of a mechanical system. Lab fee of $30 required. Prerequisite: MECH 3350; it is recommended that the laboratory is taken the next long semester after completion of MECH 3350. (0-3) S

MECH 3305 Computer Aided Design (3 semester credit hours) Lecture course. Course material includes an introduction to Computer-Aided Design (CAD) tools and their applications to the geometric design and analysis of mechanical components and assemblies. CAD software will be used to generate sketches, curves, surfaces, solids, assemblies, and engineering drawing suitable for different manufacturing processes. Innovative team-oriented projects are integrated into the course. Prerequisites: MECH 1208 and ENGR 2300. Prerequisite or Corequisite: CS 1325 or (CE 1337 or CS 1337). Corequisite: MECH 3105. (3-0) S

MECH 3310 Thermodynamics (3 semester credit hours) Lecture course. This course focuses on introductory concepts and definitions of thermodynamics: energy and the first law of thermodynamics; evaluating properties and Ideal gas model; control volume analysis using energy; entropy and the second law of thermodynamics; refrigeration and power systems, Prerequisites: MECH 1208 and ENGR 3300 and PHYS 2325. Prerequisite or Corequisite: CHEM 1311. (3-0) S

MECH 3315 Fluid Mechanics (3 semester credit hours) Lecture course. Governing equations will be derived applying conservation of mass, momentum and energy to a control volume. The flow behavior will be studied using the integral form of the governing equations for mechanical engineering applications (turbines, pumps, moving bodies). Assuming inviscid and irrotational flow, potential theory, Bernouilli equation, and Stokes theorem on the circulation will be discussed. Analysis of engineering applications of incompressible pipe systems, external aerodynamics, and computer solutions will be examined. Prerequisites: MECH 2330 and ENGR 3300. Prerequisite or Corequisite: MECH 3310. (3-0) S

MECH 3320 Heat Transfer (3 semester credit hours) Lecture course. This course focuses on steady state and time-dependent 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) S

MECH 3340 System Dynamics Modeling and Analysis (3 semester credit hours) Lecture course. Dynamic analysis and simulation of common engineering systems with thermal, fluid, mechanical and electromechanical applications. Laplace transform techniques, time domain, and frequency response methods are used along with simulation techniques to analyze and predict system response to various input stimuli. Matlab and Simulink are used extensively throughout the course. Prerequisite: MECH 3315. (3-0) Y

MECH 3350 Kinematics and Dynamics of Mechanical Systems (3 semester credit 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) S

MECH 3351 Design of Mechanical Systems (3 semester credit 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) S

MECH 3360 Introduction to Materials Science (3 semester credit hours) Lecture course. 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 the roles of materials in modern technology by case studies of advances in new materials and processes. 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. Credit cannot be received for both MECH 3360 and (ECS 3310 or MSEN 3310). Prerequisites: CHEM 1311 and (MATH 2415 or MATH 2419 or equivalent) and PHYS 2326 or instructor consent required. (3-0) Y

MECH 3370 Applied Thermodynamics (3 semester credit hours) Lecture course. This course extends the coverage of thermodynamics beyond that found in an introductory Thermodynamics. Applications are emphasized by examining the use of thermodynamic concepts to analyze various devices, systems, and processes. The course includes a more advanced treatment of fundamental thermodynamic concepts as well as an introduction to several advanced topics of relevance to mechanical engineering such as energy, reacting and non-reacting mixtures, psychometrics, and combustion. Prerequisites: MECH 3310 and MECH 3315. (3-0) Y

MECH 3380 Introduction to Computational Design and Analysis (3 semester credit hours) Lecture course. This course covers analytical and computer-based methods to design and analyze engineering structures. The course builds on prerequisite knowledge in mechanical engineering design, mechanics of materials, physics, engineering mathematics, and computer programming. The scope includes fundamentals of product design requirements, evaluation of stress and deformations in solids with complex geometries, and manufacturing process considerations. The course introduces 1-D boundary value problems, numerical solution methods (finite element analysis), and various computational tools to assess failure criteria. Additional topics include identifying linear vs. nonlinear structural problems, function approximation tools to reduce simulation time, and design optimization techniques. Computer programming and computer-based solid modeling/analysis tools are integrated into the course to facilitate the design and evaluation of complex, real-world problems. Prerequisites: CS 1325 and MATH 2420 and MECH 2320 and MECH 3305 or equivalents. (3-0) Y

MECH 3381 Introduction to Manufacturing Processes (3 semester credit hours) Lecture course. This course is designed to provide students with an overview of some fundamental manufacturing processes, including machining, casting and forming, and welding. It also has important coverage of non-traditional manufacturing processes, such as plasma arc cutting and additive manufacturing. The basic principles behind these processes will be discussed with the purpose of providing essential working principles of various fundamental manufacturing processes.

Prerequisite: MECH 1208. Prerequisite or Corequisite: MECH 3305. (3-0) Y

MECH 3V95 Topics in Mechanical Engineering (1-9 semester credit hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary. Additional prerequisites may be required depending on the specific course topic. (9 semester credit hours maximum). ([1-9]-0) R

MECH 4110 Systems and Controls Laboratory (1 semester credit hour) Laboratory course associated with MECH 4310. Course focused on the modeling and parameter estimation of dynamical systems, and the design of control systems. Lab fee of $30 required. Prerequisite: MECH 3340. Corequisite: MECH 4310. (0-3) S

MECH 4301 Intermediate Mechanics of Materials (3 semester credit hours) Lecture course. Course material includes topics such as principal stresses; constitutive relations, thermal strains; stress concentration, brittle and ductile failure; fracture and fatigue; two-dimensional linear elasticity; material plasticity; energy concepts, unit load method, Castigliano's theorems; St. Venant theory, shear center; curved beams; introduction to plates. Prerequisites: MECH 2320 and ENGR 3300. (3-0) Y

MECH 4310 Systems and Controls (3 semester credit 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. Prerequisite: MECH 3340. Corequisite: MECH 4110. (3-0) S

MECH 4320 Applications of Computational Tools in Thermal Fluid Science (3 semester credit hours) Lecture course. Introduction to the methods used to simulate fluid flow and heat transfer, with an emphasis on the selection and use of commercial analysis packages. This course covers basic numerical analysis and the application of these techniques to the solution of the relevant transport equations in thermal-fluid science. Discussion of how engineering problems can be formulated and solved using various commercial software packages. Prerequisite: MECH 3320. (3-0) Y

MECH 4330 Intermediate Fluid Mechanics (3 semester credit hours) Lecture course. Key concepts such as: stability, buoyancy, conservation of momentum and angular momentum, and potential flow will be reviewed. Working mechanism of fluid machinery (such as pumps, gas turbines engines, fans) as well as open channel flows (river) will be discussed in detail. An introduction to the effects of compressibility will be given and the equations of normal shocks and streamlined isentropic tubes will be derived. Prerequisite: MECH 3315. (3-0) Y

MECH 4340 Mechanical Vibrations (3 semester credit 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 4342 Introduction to Robotics (3 semester credit hours) Fundamentals of robotics, rigid motions, homogeneous transformations, forward and inverse kinematics, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Lab fee of $30 required. Prerequisite or Corequisite: BMEN 4310 or EE 4310 or MECH 4310 or equivalent. (Same as BMEN 4342 and EE 4342) (2-3) Y

MECH 4360 Introduction to Nanostructured Materials (3 semester credit 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: MECH 2320 and MECH 3310. (3-0) Y

MECH 4365 Energy Analytics (3 semester credit hours) Lecture course. Energy analytics introduces energy systems and data analytics, which include the use of data, statistical and quantitative analysis, exploratory and predictive models, and data visualization to inform power and energy systems decisions and actions. The key objective of this course is to familiarize the students with most important analytics technologies used in managing and analyzing big data in energy systems (especially in renewable energy systems such as wind and solar). This course will cover major energy-related applications of descriptive and predictive analytics, such as energy data analysis, energy resource analytics, design of experiments, response surface, load forecasting, price forecasting, renewable generation forecasting, demand response and customer analytics, and utilities outage analytics. Students will use R/Python for project design. The course builds on prerequisite knowledge in engineering mathematics, probability, and statistics. Prerequisites: ENGR 2300 and ENGR 3300 and ENGR 3341. (3-0) Y

MECH 4370 Introduction to MEMS (3 semester credit hours) The goal of this course is to provide an introduction to M/NEMS fabrication techniques, selected device applications, and the design tradeoffs in developing systems. Prerequisites: (MECH 3310 and MECH 3350 and PHYS 2126 and PHYS 2326) or (CE 3310 or EE 3310). (Same as EE 4371) (3-0) Y

MECH 4380 HVAC Systems (3 semester credit hours) Lecture course. This course is an introduction to the analysis and design of heating, ventilation, air conditioning, and refrigeration systems. The emphasis is on the application of fundamental heat transfer and fluid mechanics principles to the analysis of HVAC systems. Topics include: introduction to human comfort and health requirement, heating and cooling load calculations and air distribution systems. Prerequisite: MECH 3320. (3-0) Y

MECH 4381 Senior Design Project I (3 semester credit 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, design, and engineering analysis, MECH 4382 on prototype construction and testing. As designated MECH Writing-Intensive Courses, 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 3340 and ECS 3390. (3-0) Y

MECH 4382 Senior Design Project II (3 semester credit 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, design, and engineering analysis, MECH 4382 on prototype construction and testing. As designated MECH Writing-Intensive Courses, 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 credit hours) For students conducting independent research for honors theses or projects. Instructor consent required. (3-0) R

MECH 4V95 Topics in Mechanical Engineering (1-9 semester credit hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary. Additional prerequisites may be required depending on the specific course topic. (9 semester credit hours maximum). ([1-9]-0) R

MECH 4V96 Individual Instruction in Mechanical Engineering (1-6 semester credit hours) Selected advanced topics in mechanical engineering. For letter grade credit only. May be repeated for credit as topics vary (6 semester credit hours maximum). Instructor consent required. ([1-6]-0) R

MECH 4V98 Undergraduate Research in Mechanical Engineering (1-9 semester credit hours) Topics will vary from semester to semester. May be repeated for credit (9 semester credit hours maximum). Instructor consent required. ([1-9]-0) R

Materials Sciences and Engineering

MSEN 3301 Introduction to Nanoscience and Nanotechnology (3 semester credit 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 and (MATH 2415 or MATH 2419 or equivalent) and (PHYS 2326 or PHYS 3342). (Same as ECS 3301) (3-0) Y

MSEN 3302 Microscopy, Spectroscopy, and Nanotech Instrumentation (3 semester credit 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 and (MATH 2415 or MATH 2419 or equivalent) and PHYS 2326. (3-0) Y

MSEN 3304 Materials Science for Sustainable Energy (3 semester credit hours) The global community is actively developing renewable energy sources to replace fossil fuels and to minimize their negative impact on climate change. Materials science is providing key enabling technologies for the development of diverse renewable energy sources (solar cells, biofuels, wind, geothermal etc.) and their practical utilization (energy storage, fuel cells, electrical vehicles, etc.). This course examines energy and climate issues, and describes the role of materials science and nanotechnology in the development and implementation of sustainable energy solutions.

Prerequisites: CHEM 1311 and (MATH 2415 or MATH 2419 or equivalent) and (PHYS 2326 or PHYS 3342). (3-0) R

MSEN 3310 Introduction to Materials Science (3 semester credit 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. Credit cannot be received for both MECH 3360 and (ECS 3310 or MSEN 3310). Prerequisites: CHEM 1311 and (MATH 2415 or MATH 2419 or equivalent) and PHYS 2326 or instructor consent required. (Same as ECS 3310) (3-0) Y

MSEN 3340 Materials Processing (3 semester credit hours) Materials processing describes the way in which we fabricate finished goods from raw materials. This course will explore the fundamental properties and strategies of materials processing, beginning with an overview of thermodynamic and kinetic principles that underpin this process. The methods of processing metallic, ceramic, electronic, and polymer materials will be discussed, with an eye on how a material's processing relates to its structure and performance. Laboratory work will provide hands-on experience on the preparation and processing techniques discussed in lecture. This course will cover a variety of materials that are frequently used in materials science, chemistry, physics, and various engineering fields. Prerequisites: CHEM 1311 and (MATH 2415 or MATH 2419 or equivalent) and (PHYS 2326 or PHYS 2422). (2-[2-3]) Y

MSEN 3V11 Topics in Materials Science and Engineering (1-3 semester credit hours) Subject matter will vary from semester to semester. May be repeated for credit as topics vary. (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. ([1-3]-0) R

MSEN 4391 Technology of Plasma (3 semester credit 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). Recommended: ENGR 3341. Prerequisites: ENGR 3300 and (CE 3310 or EE 3310). (Same as EE 4391) (3-0) T

MSEN 4V95 Undergraduate Research (1-9 semester credit hours) Provides students with experience in a laboratory setting. Hands-on opportunity to interact with professors and companies in the field. May be repeated for credit (9 semester credit hours maximum). Prerequisites or Corequisites: MSEN 3301 and MSEN 3302 and instructor consent required. ([1-9]-0) S

Software Engineering

SE 2340 Computer Architecture (3 semester credit 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. Credit cannot be received for both courses, (CS 2340 or SE 2340) and (CE 4304 or EE 4304). Prerequisites: (CE 1337 or CS 1337) with a grade of C or better or equivalent and (CE 2305 or CS 2305) with a grade of C or better. (Same as CS 2340) (3-0) S

SE 2V95 Individual Instruction in Software Engineering (1-6 semester credit hours) Individual study under a faculty member's direction. May be repeated for credit as topics vary (6 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-6]-0) R

SE 3162 Professional Responsibility in Computer Science and Software Engineering (1 semester credit hour) Professional and ethical responsibilities of computer scientists and software engineers as influenced by growth in computer use and networks. Costs and benefits of computer technology. Risks and liabilities of safety-critical systems. Social implications of the Internet. Interaction between human values and technical decisions involving computing. Intellectual Property. Global impact of computing. Prerequisites or Corequisites: CS 3345 and CS 3354. (Same as CS 3162) (1-0) S

SE 3306 Mathematical Foundations of Software Engineering (3 semester credit 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. Credit cannot be received for both courses, CS 3305 and SE 3306. Double majors are required to take CS 3305. Prerequisite: (CE 2305 or CS 2305) with a grade of C or better or equivalent. (3-0) S

SE 3341 Probability and Statistics in Computer Science and Software Engineering (3 semester credit 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. Credit cannot be received for both courses, (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) with a grade of C or better. (Same as CS 3341 and STAT 3341) (3-0) S

SE 3345 Data Structures and Introduction to Algorithmic Analysis (3 semester credit 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. Prerequisites: ((CE 2305 or CS 2305) with a grade of C or better or (Data Science major and MATH 3315)) and (CE 2336 or CS 2336 or CS 2337) with a grade of C or better. Prerequisite or Corequisite: (CS 3341 or SE 3341 or ENGR 3341) or (Data

Science major and STAT 3355). (Same as CE 3345 and CS 3345) (3-0) S

SE 3354 Software Engineering (3 semester credit 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 CS 2337) with a grade of C or better or CS 3333) and (CE 2305 or CS 2305) with a grade of C or better or equivalent. Prerequisite or Corequisite: ECS 3390. (Same as CE 3354 and CS 3354) (3-0) S

SE 3377 Systems Programming in UNIX and Other Environments (3 semester credit hours) Basic UNIX concepts, commands and utilities, organization of UNIX file system including links and access control, creating and managing UNIX processes and threads, implementing algorithms using shell scripts, basic networking concepts including socket and client-server programming, inter-process communication using pipes and signals, using a version control system to manage work, and introduction to cloud computing. Design and implementation of a comprehensive programming project is required. Prerequisite: (CE 2336 or CS 2336 or CS 2337) with a grade of C or better or equivalent. (Same as CS 3377) (3-0) S

SE 3V95 Undergraduate Topics in Software Engineering (1-9 semester credit hours) May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-9]-0) S

SE 4347 Database Systems (3 semester credit 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. (Same as CS 4347) (3-0) Y

SE 4348 Operating Systems Concepts (3 semester credit 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 2340 or SE 2340) or equivalent and (CS 3377 or SE 3377) and (CE 3345 or CS 3345 or SE 3345). (Same as CS 4348) (3-0) S

SE 4351 Requirements Engineering (3 semester credit 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 credit 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 credit 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 Design (3 semester credit 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. Prerequisites: (CE 2336 or CS 2336 or CS 2337) with a grade of C or better or equivalent and (CE 3354 or CS 3354 or SE 3354). (Same as CS 4376) (3-0) S

SE 4381 Software Project Planning and Management (3 semester credit 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 credit hours) For students conducting independent research for honors theses or projects. Topics may vary. Additional prerequisites may be required depending on the specific course topic. Instructor consent required. (3-0) R

SE 4485 Software Engineering Project (4 semester credit 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. Lab fee of $30 required. Prerequisites: At least two of the following: SE 4351 or SE 4352 or SE 4367 or SE 4381. (4-1) S

SE 4V95 Undergraduate Topics in Software Engineering (1-9 semester credit hours) May be used as SE Guided Elective on SE degree plans. Additional prerequisites may be required depending on the specific course topic. Instructor consent required. May be repeated for credit as topics vary (9 semester credit hours maximum). Prerequisite: CS 3345 or SE 3345 or CE 3345. ([1-9]-0) R

SE 4V98 Undergraduate Research in Software Engineering (1-9 semester credit hours) May be repeated for credit as topics vary (9 semester credit hours maximum). Additional prerequisites may be required depending on the specific course topic. Instructor consent required. ([1-9]-0) R