All co- and prerequisites must be passed with a C or better. All 4000 level courses require admittance into Professional Program.

**CSE 1105. INTRODUCTION TO COMPUTER SCIENCE AND ENGINEERING (1-0)**
Introduction to engineering concepts, the computer science and engineering disciplines, skills for written communication, and departmental orientation.

**CSE 1301. COMPUTER LITERACY (2-3)** For those persons having an interest in finding out what a computer is (and is not), the types of problems suited for computers, and how to utilize a computer to solve problems. The organization and characteristics of computers; application of commercial software such as word processors, spreadsheets, database packages, and communications packages.

**CSE 1309. INTRODUCTION TO PROGRAMMING FOR NON-ENGINEERING MAJORS (3-0)** An introduction to the computer, to the algorithmic process, and to programming using basic control and data structures. This course is taught using the Python programming language. Co-requisite: MATH 1302 or subsequent math course.

**CSE 1310. INTRODUCTION TO COMPUTERS & PROGRAMMING (3-0)** An introduction to the computer, to the algorithmic process, and to programming using basic control structures, arrays, and files. Windows and UNIX operating systems are used. Prerequisite: C or better in MATH 1302 or C or better in (or concurrent enrollment in) a subsequent mathematics course (MATH 1421, MATH 1426, MATH 2425, MATH 2326, MATH 3330, HONR-SC 1426 or HONR-SC 2425) and C or better in CSE 1105 (or concurrent enrollment), and C or better in UNIV 1131 or ENGR 1101 (or concurrent enrollment).

**CSE 1311. INTRODUCTION TO PROGRAMMING FOR ENGINEERS (3-0)** An introduction to the algorithmic process and to programming in C using standard control structures, arrays, files, strings, pointers, bit manipulation and structures. Prerequisite: MATH 1421 or subsequent math course (or concurrently).

**CSE 1312. MATHEMATICAL INTRODUCTION TO COMPUTERS & PROGRAMMING (3-0)** Substitute for CSE 1310, but with broader connections to mathematical problem-solving, basic code quality issues, and evaluation of program execution properties. Credit will not be given for both CSE 1310 and CSE 1312. Prerequisite: MATH 1421 or subsequent math course. Co-requisite: CSE 1105

**CSE 1320. INTERMEDIATE PROGRAMMING (3-0)** Programming concepts beyond basic control and data structures. Emphasis is given to data structures including linked-lists and trees as well as modular design consistent with software engineering principles. Prerequisite: C or better in CSE 1310 or C or better in CSE 1312, and C or better in (or concurrent enrollment in) (MATH 1421, MATH 1426, MATH 2425, MATH 2326, MATH 3330, HONR-SC 1426, or HONR-SC 2425) and C or better in CSE 1105 (or concurrent enrollment), and C or better in UNIV 1131 or ENGR 1101 (or concurrent enrollment).
CSE 1325. OBJECT-ORIENTED PROGRAMMING (3-0) Object-oriented concepts, class diagrams, collection classes, generics, polymorphism, and reusability. Projects involve extensive programming and include graphical user interfaces and multithreading. Prerequisite: CSE 1320.

CSE 1392, 2392, 3392. SPECIAL TOPICS (3-0) New developments in the field of computer science and engineering. Topic may vary from semester to semester. May be repeated for credit when topic changes. Departmental approval required in advance to use for degree credit. Prerequisite: consent of advisor.

CSE 2100. PRACTICAL COMPUTER HARDWARE/SOFTWARE SYSTEMS (0-3) A practical approach to hands-on computer hardware and software systems in a laboratory environment. Students will be exposed to basic design concepts using off-the-shelf hardware components and to tools that enable the design of complex software systems. Prerequisite: CSE 1320.

CSE 2312. COMPUTER ORGANIZATION & ASSEMBLY LANGUAGE PROGRAMMING (3-0) Computer organization from the viewpoint of software, including: the memory hierarchy, instruction set architectures, memory addressing, input-output, integer and floating-point representation and arithmetic. The relationship of higher-level programming languages to the operating system and to instruction set architecture are explored, along with programming in an assembly language. Prerequisite: CSE 1320.

CSE 2315. DISCRETE STRUCTURES (3-0) Propositional and predicate logic, mathematical proof techniques, sets, combinatorics, functions and relations, graphs, and graph algorithms. Prerequisite: C or better in CSE 1310 or CSE 1312 and MATH 1426 (or C or better in or concurrent enrollment in MATH 2425) and C or better in ENGR 1250 (or concurrent enrollment).

CSE 2320. ALGORITHMS & DATA STRUCTURES (3-0) Design and analysis of algorithms with an emphasis on data structures. Approaches to analyzing lower bounds on problems and upper bounds on algorithms. Classical algorithm design techniques including algorithms for sorting, searching, and other operations on data structures such as hash tables, trees, graphs, strings, and advanced data structures, dynamic programming and greedy approaches. Prerequisite: CSE 1320 and CSE 2315.

CSE 2440. CIRCUITS AND SIGNALS (3-3) Basic principles of electrical circuits using resistors, capacitors and inductors. Filter analysis and synthesis using complex algebra. Introduction to operational amplifiers. Time domain and frequency domain analysis and taxonomy of signals. Concurrent laboratory experiments complement lecture topics. Prerequisite: C or better in MATH 2425 and PHYS 1444.

CSE 2441. INTRODUCTION TO DIGITAL LOGIC (3-3) Analysis, design and testing of combinational and sequential logic circuits. Topics include Boolean algebra, logic circuit minimization techniques, synchronous sequential circuit design, algorithmic state machine design, design of arithmetic/logic and control units. Computer aided design tools are utilized throughout the course. Prerequisite: CSE 1320 and CSE 2315.

CSE 3302. PROGRAMMING LANGUAGES (3-0) Introduction, analysis, and evaluation of the important concepts found in a variety of programming languages. Formalisms useful in specifying language syntax and semantics; programming language paradigms such as algorithmic, functional, logic, and object-oriented. Prerequisite: CSE 1325, CSE 2312 and CSE 2320.
CSE 3310. FUNDAMENTALS OF SOFTWARE ENGINEERING (3-0) Software engineering principles, processes, and techniques; software development approaches focusing on functional analysis and functional design methods. Configuration management, implementation strategies, and testing. Team project. Prerequisite: CSE 1325 and CSE 2315.

CSE 3311. OBJECT-ORIENTED SOFTWARE ENGINEERING (3-0) Study of an agile unified methodology and its application to object-oriented software development. Topics include requirements acquisition, use case derivation, modeling and design of interaction behavior and state behavior, introduction to design patterns, derivation of design class diagrams, implementation considerations and deployment. Team project. Prerequisite: CSE 1325, CSE 2320, and CSE 3310.

CSE 3313. INTRODUCTION TO SIGNAL PROCESSING (3-0) Examines models for presentation and processing of digital signals. Sampling theorem, correlation and convolution, time and frequency analysis of linear systems, Fourier transform, Z-transform, design of digital filters structures for discrete time systems. Prerequisite: CSE 2320 and either CSE 3380 or MATH 3330.

CSE 3315. THEORETICAL CONCEPTS IN COMPUTER SCIENCE AND ENGINEERING (3-0) Selected theoretical concepts including regular and context free languages, finite state and pushdown automata, Turing machines, computability, and NP-completeness. Prerequisite: CSE 2315.

CSE 3320. OPERATING SYSTEMS (3-0) Functions and components of an operating system, including process synchronization, job scheduling, memory management, file systems protection, and deadlocks. Related system software, such as loaders, linkers, assemblers, and windowing systems. Prerequisite: C or better in CSE 2312.


CSE 3330. DATABASE SYSTEMS AND FILE STRUCTURES (3-0) Database system architecture; file structures for databases, including indexing hashing, and B+-trees; the relational model and algebra; the SQL database language; Entity-Relationship data modeling; functional dependencies and basic normalization. Prerequisite: CSE 1325 and CSE 2320.

CSE 3380. LINEAR ALGEBRA FOR CSE (3-0) Solving systems of equations, matrix algebra, determinants, vector spaces, orthogonality and least squares, with applications to computer science. Prerequisite: CSE 2315.

CSE 3442. EMBEDDED COMPUTER SYSTEMS I (3-3) Design of microcontroller-based systems, including microprocessor programming, component and system architectures, memory interfacing, asynchronous and synchronous serial interfaces, timer-based peripherals, analog to digital (A/D) and digital to analog (D/A) converters, and typical applications. Prerequisite: C or better in each of the following: CSE 2100, CSE 2312, CSE 2440 and CSE 2441.

CSE 4191. INDIVIDUAL PROJECTS (1-0) Special problems in computer science and engineering on an individual basis. Topics may change from semester to semester. May be repeated for credit. Departmental approval must be obtained in advance for degree credit. Prerequisite: consent of instructor and department chairperson.
CSE 4303. COMPUTER GRAPHICS (3-o) Theory and practice for the visual representation of data by computers including display devices, output primitives, planes and curved surfaces, two- and three-dimensional transformations, parallel and perspective viewing, removal of hidden lines and surfaces, illumination models, ray tracing, radiosity, color models, and computer animation. Prerequisite: CSE 2320, and either CSE 3380 (or MATH 3330).

CSE 4305. COMPILERS FOR ALGORITHMIC LANGUAGES (3-o) Review of programming language structures, translation, and storage allocation. Theory and practice of compilers and issues in compiler construction including parsing, intermediate code generation, local optimization problems such as register allocation, data-flow analysis, and global optimization. Prerequisite: CSE 3302 and CSE 3315.

CSE 4308. ARTIFICIAL INTELLIGENCE (3-o) An introduction to the field of artificial intelligence studying basic techniques such as heuristic search, deduction, learning, problem solving, knowledge representation, uncertainty reasoning and symbolic programming languages such as LISP. Application areas may include intelligent agents, data mining, natural language, machine vision, planning and expert systems. Prerequisite: Admitted into an Engineering Professional Program. C or better in each of the following: CSE 2320 and (IE 3301 or MATH 3313).

CSE 4309. INTRODUCTION TO MACHINE LEARNING (3-o) This course offers an introduction to machine learning. Topics include naïve Bayes classifiers, linear regression, linear classifiers, neural networks and backpropagation, kernel methods, decision trees, feature selection, clustering, and reinforcement learning. A strong programming background is assumed. Prerequisites: Admitted into an Engineering Professional Program. C or better in each of the following: CSE 2320, IE 3301 or MATH 3313, and CSE 3380 or MATH 3330.

CSE 4310. INTRODUCTION TO COMPUTER VISION (3-o) This course introduces students to basic concepts and techniques in computer vision,. The topics covered include morphological operations, connected component analysis, image filters, edge detection, feature extraction, object detection, object recognition, tacking, gesture recognition, image formation and camera models, calibration, and stereo vision. A strong programming background is assumed. Prerequisites: Admitted into an Engineering Professional Program. C or better in each of the following: CSE 2320, IE 3301 or MATH 3313, and CSE 3380 or MATH 3330.

CSE 4314. PROFESSIONAL PRACTICES (3-o) Ethics. Contemporary social aspects and responsibilities of computing in a global, societal context. Lifelong learning goals and resources. Entrepreneurship and intellectual property. Project involving written and oral communication. Prerequisites: COMS 2302.

CSE 4316. COMPUTER SYSTEM DESIGN PROJECT I (2-3) Analysis and design of an industry-type project that involves hardware and software components to meet desired needs within realistic constraints and standards. The project is to be completed in CSE 4317 the following semester. Multidisciplinary teams of CSE 4316 students are required to develop, review, and present problem definition, project planning, requirements formulation, and design specification. Prerequisite: Admitted into a CSE Professional Program. For academic plan CS_CS or SE_SE, C or better in CSE 3310 and CSE 3320, and C or better in CSE 4314 (or concurrently). For academic plan CSE_CP, C or better in CSE 3320 and CSE 3442, and C or better in CSE 4314 (or concurrently).
CSE 4317. COMPUTER SYSTEM DESIGN PROJECT II (2-3) Implementation, integration, quality assurance through peer review and testing, and deployment of the project designed in CSE 4316; oral presentation, documentation and project demonstration. Prerequisite: CSE 4316 and continuation with the same team.

CSE 4319. MODELING AND SIMULATION (3-0) Techniques for system modeling and simulation of stochastic and knowledge-based systems. Modeling methods, model validation and verification procedures, and steady state solution techniques. Prerequisite: Admitted in an Engineering Professional Program. C or better in each of the following: CSE 3310 and IE 3301 or MATH 3313.

CSE 4321. SOFTWARE TESTING & MAINTENANCE (3-0) Study of software quality assurance, software testing, and software maintenance processes, methods and techniques including formal review techniques, software verification, validation, and testing, types of software maintenance, maintenance activities, and regression testing. Prerequisite: CSE 3310.

CSE 4322. SOFTWARE PROJECT MANAGEMENT (3-0) Introduction to software project management. Issues include effort estimation and costing, project planning and scheduling, option analysis, software quality assurance, and formal technical reviews. Prerequisite: CSE 3310.

CSE 4323. QUANTITATIVE COMPUTER ARCHITECTURE (3-0) Pipelined processors, parallel processors including shared and distributed memory, multicore, VLIW and graphics processors, memory and cache design, computer peripherals, and computer clusters. Prerequisite: CSE 3320.

CSE 4331. DATABASE IMPLEMENTATION AND THEORY (3-0) Review of the relational model and algebra; relational calculus; relational database design theory; advanced data modeling concepts; object-oriented and object-relational databases; database system implementation techniques, including concurrency control, recovery, atomic commitment, and query processing and optimization, database security; introduction to advanced concepts, such as active, deductive, spatial, temporal, multimedia and distributed databases. Prerequisite: CSE 3330.

CSE 4334. DATA MINING (3-0) Automatic discovery of patterns and knowledge from large data repositories, including databases, data warehouses, Web, document collections, and transactions. Basic topics of data mining, including data preprocessing, data warehousing and OLAP, data cube, frequent pattern and association rule mining, correlation analysis, classification and prediction, and clustering, as well as advanced topics covering the techniques and applications of data mining on Web and text documents. Prerequisites: IE 3301 or MATH 3313. Co-requisite: CSE 3330.

CSE 4340. MOBILE SYSTEMS ENGINEERING (3-0) Mobile devices including handheld computers, sensor nodes and smart phones, operating systems, middleware and communication in mobile environments. Applications of mobile systems in health, entertainment, security and other areas. Prerequisite: CSE 3320 and Co-requisite: CSE 4344.

CSE 4342. EMBEDDED SYSTEMS II (2-3) Advanced course in design of microcontroller-based systems. Emphasis is on the application of microcontrollers, and other VLSI components to real-time, interactive, and online problems. Prerequisite: Admitted into an Engineering Professional Program. C or better in each of the following: CSE 3323, CSE 3442, and CSE 3313 (or concurrently).

CSE 4344. COMPUTER NETWORK ORGANIZATION (3-0) Design and analysis of computer networks. Emphasis on the OSI architecture but discusses other schemes (e.g., ARP Anet). Data link
control, local networks, protocols/architectures, network access protocols, transport protocols, internetworking, and ISDN. Prerequisite: CSE 3320.

CSE 4345. COMPUTATIONAL METHODS (3-0) Introduction to numerical methods for solving problems in computer science and engineering. Topics include computer arithmetic, linear and nonlinear equations, eigenvalue problems, least squares, optimization, interpolation, and simulation. Prerequisites: Admitted into an Engineering Professional Program. C or better in each of the following: IE 3301 or MATH 3313, CSE 2320, and either CSE 3380 or MATH 3330.

CSE 4351. PARALLEL PROCESSING (3-0) Theory and practice of parallel processing, including characterization of parallel processors, models for memory, algorithms, and interprocess synchronization. Issues in parallelizing serial computations, efficiency and speedup analysis. Programming exercises using one or more concurrent programming languages, on one of more parallel computers. Prerequisite: CSE 3320.

CSE 4352. IOT AND NETWORKING (3-0) Study of Ethernet stacks and layers, full implementation of an Ethernet stack and a basic low-latency, small footprint IoT protocol on bare metal embedded devices and embedded Linux systems. Prerequisite: C or better in CSE 3442.

CSE 4354. REAL-TIME OPERATING SYSTEMS (3-0) Implementation of a real-time operating system with cooperative and preemption content switching, priority scheduling, semaphores, message queues, and inter-process communications on bare metal microcontrollers. Prerequisite: C or better in both CSE 3320 and CSE 3442.

CSE 4356. SYSTEM ON CHIP (SOC) DESIGN (3-0) Design of FPGA-based system on chip solutions, including processor subsystems, FPGA fabric, processor to FPGA bridges, and device drivers. Prerequisite: C or better in CSE 3442.

CSE 4358. MICROPROCESSOR SYSTEMS (3-0) Asynchronous and synchronous memory interfacing and timing, implementation of DMA controllers and SDRAM controllers. Prerequisite: C or better in CSE 3323.

CSE 4360. AUTONOMOUS ROBOT DESIGN AND PROGRAMMING (2-3) An introduction to robotics and the design and programming of autonomous robot systems. Topics include basic kinematics, dynamics, and control, as well as sensors, knowledge representation, and programming techniques. Course work includes individual and group projects involving the building and programming of simulated and real robots. Prerequisite: CSE 2320, CSE 3320 and CSE 3380 (or MATH 3330).

CSE 4361. SOFTWARE DESIGN PATTERNS (3-0) In-depth study of software design patterns, including description of patterns, design principles and techniques used by patterns as well as application of patterns to solving practical design problems. Team project. Prerequisite: CSE 3311.

CSE 4378. INTRODUCTION TO UNMANNED VEHICLE SYSTEMS (3-0) Introduction to UVS (Unmanned Vehicle Systems) such as UAS (Unmanned Aircraft Systems), UGS (Unmanned Ground
System) and UMS (Unmanned Maritime System), their history, missions, capabilities, types, configurations, subsystems, and the disciplines needed for UVS development and operation. UVS missions could include student competitions sponsored by various technical organizations. This course is team-taught by engineering faculty. Prerequisite: Admission to a professional engineering or science program.

**CSE 4379. UNMANNED VEHICLE SYSTEM DEVELOPMENT (3-0)** Introduction to the technologies needed to create a UVS (Unmanned Vehicle System). Integration of these technologies (embodied as a set of sensors, actuators, computing and mobility platform sub-systems) into a functioning UVS through team work. UVS could be designed to compete in a student competition sponsored by various technical organizations or to support a specific mission or function defined by the instructors. This course is team-taught by engineering faculty. Prerequisite: B or better in CSE 4378 and admission to the UVS certificate program.

**CSE 4380. INFORMATION SECURITY (3-1)** Hands-on introduction to the basics of security. Includes system security, buffer overflows, a high-level overview of cryptography, firewalls and intrusion detection/prevention, malware, penetration testing, forensics, and system administration. Prerequisite: CSE 3320.

**CSE 4381. INFORMATION SECURITY II (3-0)** Deeper study of the fundamentals of security, including symmetric key cryptography, public key cryptography, cryptographic protocols, malware design, network attacks and defenses, data security, privacy, and wireless security. Prerequisite: Admitted into an Engineering Professional Program. C or better in CSE 3320 and C or better in CSE 4344 (or concurrently).

**CSE 4382. SECURE PROGRAMMING (3-0)** This course is an introduction to methods of secure software design and development. Students will learn about the major security problems found in software today. Using this knowledge, they will work in teams to find these bugs in software, fix the bugs, and design software so that it has fewer security problems. Static analysis tools will be a core part of the class, but students will also be exposed to black box testing tools. Topics will include validation, buffer overflow prevention, error handling, web application issues, and XML. Prerequisite: Admitted into an Engineering Professional Program. C or better in CSE 3320.

**CSE 4391. INDIVIDUAL PROJECTS (3-0)** Special problems in computer science and engineering on an individual basis. Topics may change from semester to semester. May be repeated for credit. Departmental approval must be obtained in advance for degree credit. Prerequisite: consent of instructor and department chairperson.

**CSE 4392. SPECIAL TOPICS (3-0)** New developments in the field of computer science and engineering. Topic may vary from semester to semester. May be repeated for credit when topic changes. Departmental approval required in advance to use for degree credit. Prerequisite: consent of instructor and professional program standing.