

2009-11 Cal Poly Catalog

[Computer Engineering Program](#)

CPE–COMPUTER ENGINEERING

CPE 100 Computer Engineering Orientation (1) (CR/NC)

Introduction to the computer engineering discipline. Success skills and curricular information. Career paths and opportunities. Professional aspects of engineering and computer science. Interaction with upper division students, alumni, faculty and staff. Introduction to computer software and hardware. Credit/No Credit grading only. 1 lecture.

CPE 101 Fundamentals of Computer Science I (4)

Basic principles of algorithmic problem solving and programming using methods of top-down design, stepwise refinement and procedural abstraction. Basic control structures, data types, and input/output. Introduction to the software development process: design, implementation, testing and documentation. The syntax and semantics of a modern programming language. Credit not available for students who have taken CSC/CPE 108. 3 lectures, 1 laboratory. Prerequisite: MATH 118 (or equivalent) with a grade of C- or better, and basic computer literacy (CSC 100 or CSC 232 or equivalent). *Crosslisted as CPE/CSC 101.*

CPE 102 Fundamentals of Computer Science II (4)

Basic design, implementation, testing, and documentation of object-oriented software. Introduction to classes, interfaces, inheritance, algorithms (sort, search, recursion), abstract data types, data structures (lists, stacks, queues), file I/O, and exceptions. Credit not available for students who have taken CSC/CPE 108. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 101 with a C- grade or better and either MATH 141 or MATH 221 with a C- grade or better. Corequisite: CSC 141. *Crosslisted as CPE/CSC 102.*

CPE 103 Fundamentals of Computer Science III (4)

Introduction to data structures and analysis of algorithms. Abstract data types. Specification and implementation of advanced data structures. Theoretical and empirical analysis and proofs of properties of recursive and iterative algorithms. Software performance evaluation and testing techniques. 3 lectures, 1 laboratory. Prerequisite: CPE 102 with a C- grade or better and CSC 141 with a C- grade or better. *Crosslisted as CPE/CSC 103.*

CPE 108 Accelerated Introduction to Computer Science (4)

Accelerated introduction to basic principles of algorithmic and object-oriented problem solving and programming. Introduction to programming language concepts including control structures, data types, classes, and inheritance. Program design principles. Use and implementation of algorithms (searching, sorting, recursion) and data structures (lists, stacks, and queues). Intended for students with experience in algorithmic problem solving and using basic control structures and data types in a modern programming language (CSC/CPE 101), but who are not ready for CSC/CPE 102. Credit not available for students who have taken CSC/CPE 102. 3 lectures, 1 laboratory. Prerequisite: Math 118 (or equivalent) with a grade of C- or better, significant experience in computer programming, and consent of instructor. Corequisite: CSC 141. *Crosslisted as CPE/CSC 108.*

CPE 129 Digital Design (3)

Number systems, Boolean algebra, Boolean functions, and minimization. Analysis and design of combinational logic circuits. Feedback circuits. Analysis and design of sequential logic circuits. Applying Hardware Description Language (HDL) to synthesize digital logic circuits in Programmable Logic Devices (PLDs). 3 lectures. Prerequisite: An orientation course in student's major (EE 111/151 for EE students, CPE 100 for CPE students), CPE/CSC 101. Concurrent: CPE 169. *Crosslisted as CPE/EE 129.*

CPE 169 Digital Design Laboratory (1)

Experiments to analyze and design combinational and sequential logic circuits with discrete ICs and PLDs. Introduction to laboratory equipment such as the logic state analyzer for testing circuits. Introduction to a hardware description language for logic simulation and design. 1 laboratory. Prerequisite: An orientation course in student's major (EE 111/151 for EE students, CPE 100 for CPE students), CPE/CSC 101. Concurrent: CPE 129. *Crosslisted as CPE/EE 169.*

CPE 200 Special Problems for Undergraduates (1–2)

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Consent of instructor.

CPE 209 Problem Solving with Computers (1) (CR/NC)

Reinforcement of computer science fundamentals. Review of important algorithms, language features, design, syntax, and testing techniques. Repeated application of techniques to solve problems in a constrained amount of time. Primarily intended to support students preparing for the Association for Computing Machinery's International Collegiate Programming Contest. Credit/No Credit grading only. Total credit limited to 15 units. 1 laboratory. Prerequisite: CSC/CPE 101 or CSC/CPE 108 with a grade of C- or better, or consent of instructor. *Crosslisted as CPE/CSC 209.*

CPE 225 Introduction to Computer Organization (4)

Introduction to computer systems. Simple instruction set architecture and the computer hardware needed to implement that architecture. Machine and assembly language programming. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 102. *Crosslisted as CPE/CSC 225.*

CPE 229 Computer Design and Assembly Language Programming (3)

Design and implementation of digital computer circuits via CAD tools for programmable logic devices (PLDs). Computer design including datapath components and control unit. Assembly language programming. Instruction set architecture, hardware/software interface, performance evaluation of computer processors. 3 lectures. Prerequisite: CPE/EE 129&169 **with a C- grade or better**. Concurrent: CPE/EE 269. *Crosslisted as CPE/EE 229. (Change effective Spring 2010)*

CPE 235 Fundamentals of Computer Science for Scientists and Engineers I (4)

Introduction to the fundamentals of computer programming with an emphasis on mathematical, scientific and engineering applications: principles of algorithmic problem solving and procedural programming using a modern programming language, data types, elementary data structures, input/output and control structures. Not a substitute for CSC/CPE 101 for CSC/CPE majors or minors. 3 lectures, 1 laboratory. Prerequisite: MATH 141 or MATH 161 with a grade of C- or better, or consent of instructor. *Crosslisted as CPE/CSC 235.*

CPE 236 Fundamentals of Computer Science for Scientists and Engineers II (4)

Further study of computer program development with an emphasis on mathematical, scientific and engineering applications. Introduction to more complicated data types and structures. Practice of more complicated techniques of procedural programming. Introduction to the principles of object-oriented programming using a modern programming language. Detailed discussion of lists and classic list algorithms, algorithm analysis, multidimensional arrays, records, dynamic data structures, file input/output, classes. Not a substitute for CSC/CPE 102 for CSC/CPE majors or minors. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 235 with a grade of C- or better, or consent of instructor. *Crosslisted as CPE/CSC 236.*

CPE 237 Introduction to Computer Science with Applications I (4)

Introduction to the fundamentals of computer science using a modern programming language. Includes principles of algorithmic problem solving, data types, elementary data structures, input/output, control structures, classes and methods. Not a substitute for CSC/CPE 101 for CSC/CPE majors or minors. 3 lectures, 1 laboratory. Prerequisite: MATH 221 or STAT 252 with a grade of C- or better, or consent of instructor. *Crosslisted as CPE/CSC 237.*

CPE 238 Introduction to Computer Science with Applications II (4)

Continuation of CPE 237. Intermediate study of computer program development using a modern object oriented (OO) programming language. Further study of OO principles including inheritance and interfaces. Introduction to implementation of Graphical User Interfaces, multi-media, streams, database connection, and scripting. Not a substitute for CPE/CSC 102 or for CSC/CPE majors or minors. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 237 with a grade of C- or better. *Crosslisted as CPE/CSC 238.*

CPE 269 Computer Design and Assembly Language Programming Laboratory (1)

Experiments to design and test digital computer circuits and systems with programmable logic devices (PLDs). Design projects to implement a basic computer with data path components and control. Assembly language programming projects for an off-the-shelf RISC-based microcontroller. 1 laboratory. Prerequisite: CPE 129&169 **with a C- grade or better**. Concurrent: CPE 229. *Crosslisted as CPE/EE 269. (Change effective Spring 2010)*

CPE 270 Computer Graphics Applications (4)

Use of common graphics applications packages. Business graphics, figure editing, animation and image editing, photorealistic image generation, scientific

visualization and multimedia. 2 lectures, 2 activities. *Crosslisted as CPE/CSC 270.*

CPE 290 Selected Topics (1–4)

Directed group study of selected topics. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Open to undergraduate students and consent of instructor.

CPE 300 Professional Responsibilities (4)

The responsibilities of the computer science professional. The ethics of science and the IEEE/ACM Software Engineering Code of Ethics. Quality tradeoffs, software system safety, intellectual property, history of computing and the social implications of computers in the modern world. Applications to ethical dilemmas in computing. Technical presentation methods and practice. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 357 and junior standing. *Crosslisted as CPE/CSC 300.*

CPE 305 Individual Software Design and Development (4)

Practical software development skills needed for construction of mid-sized production-quality software modules, using the CSC upper division programming language. Topics include inheritance, exceptions, and memory and disk-based dynamic data structures. Students must complete an individual programming project of mid-level complexity. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 357. *Crosslisted as CPE/CSC 305.*

CPE 307 Introduction to Software Engineering (4)

Requirements, specification, design, implementation, testing and verification of large software systems. Study and use of the software process and software engineering methodologies; working in project teams. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 103 with a grade of C- or better, and CSC/CPE 357. Not open to students with credit in CSC/CPE 308. *Crosslisted as CPE/CSC 307.*

CPE 308 Software Engineering I (4)

Principles for engineering requirements analysis and design of large complex software systems. Software process models. Methods of project planning, tracking, documentation, communication, and quality assurance. Analysis of engineering tradeoffs. Group laboratory project. Technical oral and written presentations. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 357. *Crosslisted as CPE/CSC 308.*

CPE 309 Software Engineering II (4)

Continuation of the software lifecycle. Methods and tools for the implementation, integration, testing and maintenance of large software systems. Software development and test environments. Software quality assurance. Group laboratory project. Technical presentation methods and practice. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 308. *Crosslisted as CPE/CSC 309.*

CPE 315 Computer Architecture (4)

In-depth study of the instruction set architecture and hardware design of a specific CPU. Introduction to pipelines, input/output and multi-processors. Computer abstractions and performance measurement. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 103 and either CPE/EE 229 or CSC 225. *Crosslisted as CPE/CSC 315.*

CPE 316 Micro Controllers and Embedded Applications (4)

Introduction to micro controllers and their applications as embedded devices. Hardware/software tradeoffs, micro controller selection, use of on-chip peripherals, interrupt driven real-time operation, A/D conversion, serial and parallel communications, watch-dog timers, low power operation and assembly language programming techniques. 3 lectures, 1 laboratory. Prerequisite: CPE/CSC 315 or CPE/EE 329. *Crosslisted as CPE/CSC 316.*

CPE 328 Discrete Time Signals and Systems (3)

Discrete-time systems and analysis, with emphasis on linear time-invariant (LTI) systems. Sampling theorem. Classification of discrete-time systems. Convolution and its application to LTI systems. The z transform, discrete-time Fourier transform, and discrete Fourier transform. Introduction to digital filters. 3 lectures. Prerequisite: EE 228 *with a C- grade or better*. Concurrent: EE/CPE 368. *Crosslisted as CPE/EE 328. (Change effective Spring 2010)*

CPE 329 Programmable Logic and Microprocessor-Based Systems Design (4)

Design, implementation and testing of programmable logic microprocessor-based systems. Hardware/software tradeoffs (such as timing analysis and power considerations), system economics of programmable logic and microprocessor-based system design. Interfacing hardware components (such as ADCs/DACs, sensors, transducers). 3 lectures, 1 laboratory. Prerequisite: EE 307&347 *with a C- grade or better*, CPE 229&269 *with a C- grade or better*. *Crosslisted as CPE/EE 329. (Change effective Spring 2010)*

CPE 336 Microprocessor System Design (4)

Introduction to microcontrollers and integrated microprocessor systems. Emphasis on the Intel 8051 and Motorola 68HC12 families and derivatives. Hardware/software trade-offs, system economics, and functional configurations. Interface design, real-time clocks, interrupts, A/D conversion, serial and parallel communications, watch-dog timers, low power operation, and assembly language programming techniques. Architecture and design of sampled data and digital control systems. Case studies of representative applications. 3 lectures, 1 laboratory. Prerequisite: CPE 129&169 *with a C- grade or better*. *Crosslisted as CPE/EE 336. (Change effective Spring 2010)*

CPE 349 Design and Analysis of Algorithms (4)

Intermediate and advanced algorithms and their analysis. Mathematical, geometrical, and graph algorithms. NP-complete problems. Additional topics will be chosen from pattern matching, file compression, cryptography, dynamic and linear programming, and exhaustive search. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 103, with a grade of C- or better, and MATH 142 and either STAT 312 or STAT 321. *Crosslisted as CPE/CSC 349.*

CPE 350 Capstone I (4)

Definition and specification of a system to be constructed in CPE 450; requirements elicitation techniques, research and data gathering methods; project planning, time and budget estimating; project team organization. Ethics and professionalism. 3 lectures, 1 laboratory. Prerequisite: CPE 329, may be concurrent.

CPE 357 Systems Programming (4)

C programming language from a system programming perspective. Standard C language including operators, I/O functions, and data types in the context of system functions. Unix commands, shell scripting, file system, editors. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 103 with a grade of C- or better, and either CSC 225 or CPE/EE 229. *Crosslisted as CPE/CSC 357.*

CPE 365 Introduction to Database Systems (4)

Basic principles of database management systems (DBMS) and of DBMS application development. DBMS objectives, systems architecture, database models with emphasis on Entity-Relationship and Relational models, data definition and manipulation languages, the Structured Query Language (SQL), database design, application development tools. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 103. *Crosslisted as CPE/CSC 365.*

CPE 366 Database Modeling, Design and Implementation (4)

The database modeling problem. Database modeling levels: external, conceptual, logical and physical. Database models: entity-relationship, relational, object-oriented, semantic, and object-relational. Normal forms. Distributed database design. Functional analysis of database applications and transaction specification, design, and implementation. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 365. *Crosslisted as CPE/CSC 366.*

CPE 368 Signals and Systems Laboratory (1)

Laboratory work pertaining to linear systems, including Fourier analysis, time and frequency responses, and system transfer function. 1 laboratory. Prerequisite: EE 228 *with a C- grade or better*. Concurrent: EE/CPE 328. *Crosslisted as CPE/EE 368. (Change effective Spring 2010)*

CPE 369 Distributed Computing I (4)

Introduction to distributed computing paradigms and protocols: interprocess communications, group communications, the client-server model, distributed objects, and Internet protocols. Emphasis on distributed software above the operating system and network layers. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 357. *Crosslisted as CPE/CSC 369.*

CPE 400 Special Problems for Advanced Undergraduates (1–4)

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units. Prerequisite: Consent of instructor.

CPE 402 Software Requirements Engineering (4)

Software requirements elicitation, analysis and documentation. Team process infrastructure and resource estimation to support appropriate levels of quality. Software architectural design. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 307 or CSC/CPE 309; CSC/CPE 305. *Crosslisted as CPE/CSC 402.*

CPE 405 Software Construction (4)

Design and construction of sizeable software products. Technical management of software development teams. Software development process models, software design, documentation, quality assurance during development, software unit and integration testing; CASE tools, development environments, test tools, configuration management. 3 lectures, 1 laboratory. Prerequisite: CPE/CSC 402. *Crosslisted as CPE/CSC 405.*

CPE 406 Software Deployment (4)

Deployment of a sizeable software product by a student team. Software maintenance and deployment economic issues. Management of deployed software: version control, defect tracking and technical support. 3 lectures, 1 laboratory. Prerequisite: CPE/CSC 405. *Crosslisted as CPE/CSC 406.*

CPE 409 Current Topics in Software Engineering (4)

Selected topics in software engineering. Topics may include program generation, quality assurance, formal methods, software metrics, design methods, testing, or software development processes. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 309 or CSC/CPE 307. *Crosslisted as CPE/CSC 409.*

CPE 415 Microcomputer Systems (4)

Recent advances in microcomputer architectures. RISC, parallel processing advances, and component communication. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 315.

CPE 416 Autonomous Mobile Robotics (4)

Theory and application of concepts relevant to autonomous mobile robots. Sensor and actuator interfacing, programming mobile robots, mobile robot configurations, software architectures and algorithms. 3 lectures, 1 laboratory. Prerequisite: CPE/EE 329 or both CSC/CPE 315 and CSC/CPE 357 or consent of instructor. *Crosslisted as CPE/CSC 416.*

CPE 427 Digital Computer Subsystems (4)

Design of components and subsystems in digital computers. Use of modern techniques and devices (CPLDs and FPGAs) in implementation. Consideration given to cost/speed tradeoffs. Implementation of a basic digital computer using pre-designed subsystems. 3 lectures, 1 laboratory. Prerequisite: CPE 329 *with a C- grade or better.* *Crosslisted as CPE/EE 427. (Change effective Spring 2010)*

CPE 428 Computer Vision (4)

Introduction to the concepts of 2D and 3D computer vision: low-level image processing methods such as filtering and edge detection; feature extraction; segmentation and clustering; stereo vision; appearance-based and model-based algorithms. 3 lectures, 1 laboratory. Prerequisite: EE 328 or CPE/CSC 357 or ME 305 or consent of instructor. *Crosslisted as CPE/EE 428.*

CPE 430 Programming Languages I (4)

Construction of the front end of a compiler including lexical analysis, syntactic analysis, type checking, and formal semantics. Introduction to regular languages, finite automata, and context-free grammars. 3 lectures, 1 laboratory. Prerequisite: CSC 349 and CSC/CPE 357. *Crosslisted as CPE/CSC 430.*

CPE 431 Programming Languages II (4)

Language principles and design issues: bindings, conversion, parameter passing, and dynamic semantics. Language implementation: intermediate code representation, memory management, code optimization, and code generation. Functional programming languages. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 430. *Crosslisted as CPE/CSC 431.*

CPE 432 Digital Control Systems (3)

Theory and applications of digital computers in linear control systems. Discrete time methods are used in analysis and design studies. Digital control systems are synthesized. 3 lectures. Prerequisite: EE 302&342 *with a C- grade or better.* Prior background in discrete time systems, e.g., EE 328, EE368 recommended. Concurrent: CPE 472. *Crosslisted as CPE/EE 432. (Change effective Spring 2010)*

CPE 435 Introduction to Object Oriented Design Using Graphical User Interfaces (4)

Principles of object-oriented design, with emphasis on use of these principles in the design of graphical interfaces. Comparison and contrasting of two major object-oriented languages and their corresponding GUI class libraries. Language-independent object-oriented design methods, and application of these methods in the construction of a GUI-based project. 3 lectures, 1 laboratory. Prerequisite: CPE 103, with a grade of C- or better, or equivalent and CPE 305. *Crosslisted as CPE/CSC 435.*

CPE 437 Dynamic Web Development (4)

Project-based study of web-based three-tiered applications, including current best practices and tools for design, implementation and testing of browser interface, serverside business logic, object-relational mapping, databases, and web services. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 357 (C- or better), CSC/CPE 365 or consent of instructor. *Crosslisted as CPE/CSC 437.*

CPE 438 Digital Computer Systems (3)

Design of computer ALU's, microprogram controllers, memory systems, and I/O controllers. Use of LSI components in CPU design. Microprogram and

nanoprogram development. 3 lectures. Prerequisite: CPE 427 or consent of instructor. *Crosslisted as CPE/EE 438.*

CPE 439 Computer Peripheral Interfacing (4)

Systems-level design and implementation of common computer peripheral devices with emphasis placed on controller and interface aspects. Use of standard and softcore microcontroller platforms with communications to discrete peripherals with I2C, SPI, CAN, and other common bus interfaces. 3 lectures, 1 laboratory. Prerequisite: CPE/EE 329 *with a C- grade or better,* or consent of instructor. *Crosslisted as CPE/EE 439. (Change effective Spring 2010)*

CPE 441 Computer-Aided Design of VLSI Devices (4)

Design of VLSI circuits, design of subsystems using static CMOS, transmission gates, and other methods. Variety of CAD tools for design, verification, test, and simulation. Several design projects. 3 lectures, 1 laboratory. Prerequisite: EE 307&347 *with a C- grade or better,* EE 308&348 *with a C- grade or better* or consent of instructor. *Crosslisted as CPE 441/EE 431. (Changes effective Spring 2010)*

CPE 448 Bioinformatics Algorithms (4)

Introduction to the use of computers to solve problems in molecular biology. The algorithms, languages, and databases important in determining and analyzing nucleic and protein sequences and their structure. 3 lectures, 1 laboratory. Prerequisite: Consent of instructor or the following: CSC/CPE 103, with a grade of C- or better, or BIO 447 and senior standing. *Crosslisted as CPE/CSC 448.*

CPE 449 Current Topics in Algorithms (4)

Selected aspects of the verification, analysis and design of algorithms. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory. Prerequisite: CSC 349. *Crosslisted as CPE/CSC 449.*

CPE 450 Capstone II (4)

Team-based design, construction and deployment of an embedded system that includes a custom-built computer. Technical management of product development teams. Technical documentation, configuration management, quality assurance, integration and systems testing. Professionalism. 3 lectures, 1 laboratory. Prerequisite: CPE 350.

CPE 453 Introduction to Operating Systems (4)

Introduction to sequential and multiprogramming operating systems; kernel calls, interrupt service mechanisms, scheduling, files and protection mechanisms, conventional machine attributes that apply to operating system implementation, virtual memory management, and I/O control systems. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 357 and either CSC/CPE 225 or CPE/EE 229. *Crosslisted as CPE/CSC 453.*

CPE 454 Implementation of Operating Systems (4)

Design and implementation of multiprogramming kernels, systems programming methodology, interprocess communications, synchronization, device drivers and network access methods. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 453. *Crosslisted as CPE/CSC 454.*

CPE 456 Introduction to Computer Security (4)

Survey of topics in computer system and network security, including protection, access control, distributed access control, operating system security, applied cryptography, network security, firewalls, secure coding practices, and case studies from real-world systems. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 453 and either CSC/CPE 300 or CPE 350. *Crosslisted as CPE/CSC 456.*

CPE 458 Current Topics in Computer Systems (4)

Selected aspects of design, implementation and analysis of networks, advanced operating and distributed systems. Topics may include process management, virtual memory, process communication, context switching, file system designs, persistent objects, process and data migration, load balancing, security and networks. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 453. *Crosslisted as CPE/CSC 458.*

CPE 461, 462 Senior Project I, II (3) (2)

Selection and completion of an individual or team project in laboratory environment. Project results are presented in a formal report. CPE 461: 3 laboratories; prerequisite: CPE 350. CPE 462: 2 laboratories; prerequisite: CPE 450.

CPE 464 Introduction to Computer Networks (4)

Computer network architectures; communications protocol standards; services provided by the network; historical and current examples presented. 3 lectures, 1 laboratory. Prerequisite: STAT 312 or STAT 321 or STAT 350 and CSC/CPE 357. *Crosslisted as CPE/CSC 464.*

CPE 465 Advanced Computer Networks (4)

Advanced topics in computer networks; greater detail of protocol standards and services provided by the network; focus on current industry and research topics. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 464 and CSC/CPE 453. *Crosslisted as CPE/CSC 465.*

CPE 466 Knowledge Discovery from Data (4)

Overview of modern knowledge discovery from data (KDD) methods and technologies. Topics in On-line Analytic Transaction Processing (OLAP), data mining (association rules mining, classification, clustering), information retrieval. Emphasis on use of KDD techniques in modern software applications. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 365 and one of STAT 312, STAT 321 or STAT 350. *Crosslisted as CPE/CSC 466.*

CPE 468 Database Management Systems Implementation (4)

Data structures and algorithms used in the implementation of database systems. Implementation of data and transaction managers: access methods interfaces, concurrency control and recovery, query processors and optimizers. Introduction to implementation of distributed database systems. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 365. *Crosslisted as CPE/CSC 468.*

CPE 469 Distributed Computing II (4)

Continued exploration of topics in distributed computing in greater depth, with emphasis on design patterns and team projects. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 369. *Crosslisted as CPE/CSC 469.*

CPE 470 Selected Advanced Topics (1-4)

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

CPE 471 Introduction to Computer Graphics (4)

Graphics software development and use of APIs for 3D graphics. The graphics pipeline, modeling, geometric and viewing transforms, lighting and shading, rendering, interaction techniques and graphics hardware. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 357. *Crosslisted as CPE/CSC 471.*

CPE 472 Digital Control Systems Laboratory (1)

Design and programming of microprocessor-based digital controls for electro-mechanical plants. Topics include digital control laws, translation of transfer functions into algorithms, assembly language programming, real-time software design, sample rate selection, finite word-length considerations. 1 laboratory. Concurrent: CPE 432. *Crosslisted as CPE/EE 472.*

CPE 473 Advanced Rendering Techniques (4)

Illumination models, reflectance, absorption, emittance, Gouraud shading, Phong shading, raytracing polyhedra and other modeling primitives, coherence, acceleration methods, radiosity, form factors, advanced algorithms. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 471. *Crosslisted as CPE/CSC 473.*

CPE 474 Computer Animation (4)

Basic and advanced algorithms for generating sequences of synthetic images. Interpolation in time and space, procedural and keyframe animation, particle systems, dynamics and inverse kinematics, morphing and video. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 471. *Crosslisted as CPE/CSC 474.*

CPE 476 Real-Time 3D Computer Graphics Software (4)

Basic and advanced algorithms for real-time, interactive, 3D graphics software. Modeling (polygon mesh, height field, scene graph), real-time rendering and shading (visibility processing, LOD, texture and light maps), collision detection (bounding volumes, complexity management), interactive controls, multi-player game technology, game engine architecture. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 471. *Crosslisted as CPE/CSC 476.*

CPE 478 Current Topics in Computer Graphics (4)

Selected aspects of the design, implementation and analysis of computer graphics. Topics may include rendering, modeling, visualization, animation, virtual reality, computer vision, multimedia, and perception issues. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 471. *Crosslisted as CPE/CSC 478.*

CPE 480 Artificial Intelligence (4)

Programs and techniques that characterize artificial intelligence. Programming in a high level language. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 103 with a grade of C- or better. *Crosslisted as CPE/CSC 480.*

CPE 481 Knowledge Based Systems (4)

In-depth treatment of knowledge representation, utilization and acquisition in a programming environment. Emphasis on the use of domain-specific knowledge

to obtain expert performance in programs. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 480. *Crosslisted as CPE/CSC 481.*

CPE 482 Advanced Topics in Systems for Computer Engineering (4)

Selected aspects of design, implementation, verification and analysis of advanced computer systems. Topics may include computer systems, embedded systems, robotics, mechatronics, haptics, human computer interfaces, digital control, digital signal processing, wireless computing, real time operating systems, and networks. The Schedule of Classes will list topic selected. Total credit limited to 8 units, repeatable in same term. 3 lectures, 1 laboratory. Prerequisite or concurrent: CPE 350, or consent of instructor.

CPE 483 Current Topics in Human-Computer Interaction (4)

Selected aspects of the field of human-computer interaction. Topics may include dynamic information visualization, universal access, social impact of technology usage, educational technology, human cognition and performance studies, and extended usability evaluation techniques. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 484. *Crosslisted as CPE/CSC 483.*

CPE 484 User-Centered Interface Design and Development (4)

Introduction to the importance of user-centered principles in the design of good interfaces and effective human-computer interaction. Topics include: study of human characteristics affected by interface design, effective requirements data collection and analysis, user-centered approaches to software engineering, and evaluation of interface and interaction quality. 3 lectures, 1 laboratory. Prerequisite: Junior standing and CSC/CPE 307 or CSC/CPE 308. *Crosslisted as CPE/CSC 484.*

CPE 485 Autonomous Robot Navigation (4)

Overview of existing autonomous mobile robot systems, basic kinematic modeling, control structures, sensing and sensor modeling, localization, and motion planning algorithms. Implementation of autonomous navigation capabilities. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 480 or consent of instructor. *Crosslisted as CPE/CSC 485.*

CPE 488 Microelectronics and Electronics Packaging (4)

Materials, processes, and reliability of microelectronics and electronics packaging, surface mount assembly and printed circuit board fabrication. Overview of semiconductor manufacturing and optoelectronics packaging. 3 lectures, 1 laboratory. Prerequisite: MATE 210 and PHYS 133 or consent of instructor. *Crosslisted as CPE 488/IME 458/MATE 458.*

CPE 489 Current Topics in Artificial Intelligence (4)

Selected aspects of the design, implementation and analysis of advanced systems and concepts in the area of artificial intelligence. Topics may include knowledge representation, reasoning, learning, or planning, and specific techniques like intelligent agents, genetic algorithms, semantic web, or robotics. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 480. *Crosslisted as CPE/CSC 489.*

CPE 493 Cooperative Education Experience (2) (CR/NC)

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 6 units. Prerequisite: Sophomore standing and consent of instructor.

CPE 494 Cooperative Education Experience (6) (CR/NC)

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 18 units. Prerequisite: Sophomore standing and consent of instructor.

CPE 495 Cooperative Education Experience (12) (CR/NC)

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. A more fully developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 24 units. Prerequisite: Sophomore standing and consent of instructor.

CPE 520 Computer Architecture (4)

Comparative study and design of multiprocessor, dataflow, RISC, high level language and other new computer architectures. VLSI processor design techniques. 3 seminars, 1 laboratory. Prerequisite: CPE 315 and graduate standing, or consent of instructor. *Crosslisted as CPE/CSC 520.*

CPE 521 Computer Systems (4)

Organization of modern general purpose, high speed digital computer systems. Design of arithmetic units, control units, memories and memory subsystems. Cost, power and speed trade-offs in the design of such systems. 3 seminars, 1 laboratory. Prerequisite: EE/CPE 329 ~~with a C-grade or better~~, or equivalent, and graduate standing or consent of instructor. *Crosslisted as CPE/EE 521. (Change effective Spring 2010)*

CPE 522 Advanced Real-Time Embedded Systems Design (4)

Theory, design and implementation of real-time operating system-based embedded systems. Scheduling algorithms, operating system resources, peripheral device interfacing and embedded system architecture. Resource management issues in a resource-limited (microcontroller-based) environment. 3 seminars, 1 laboratory. Prerequisite: Advanced C programming skills, CPE/EE 329 ~~with a C-grade or better~~ or equivalent, or consent of instructor. *Crosslisted as CPE/EE 522. (Change effective Spring 2010)*

CPE 523 Digital Systems Design (4)

Full-custom design and analysis of digital circuits using full CMOS, pass-transistor and dynamic circuit topologies. Transistor sizing for minimizing power consumption, delay and other design criteria. 3 seminars, 1 laboratory. Prerequisite: EE/CPE 329 ~~with a C-grade or better~~ or equivalent, and graduate standing or consent of instructor. *Crosslisted as CPE/EE 523. (Change effective Spring 2010)*

CPE 556 Computer Security (4)

Exploration of advanced topics in computer security with an emphasis on research topics. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 456 and graduate standing, or consent of instructor. *Crosslisted as CPE/CSC 556.*

CPE 564 Computer Networks: Research Topics (4)

Exploration of advanced topics in emerging computer networking technologies; focus on leading edge computer network research topics. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 464 and graduate standing, or consent of instructor. *Crosslisted as CPE/CSC 564.*

CPE 569 Distributed Computing (4)

Principles and practices in distributed computing: interprocess communications, group communications, client-server model, distributed objects, message queue system, distributed services, mobile agents, object space, Internet protocols. Distributed algorithms: consensus protocols, global state protocols. Fault tolerance: classification of faults, replication. Not open to students with credit in CSC/ CPE 369 or CSC/CPE 469. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 357 and graduate standing, or consent of instructor. *Crosslisted as CPE/CSC 569.*

CPE 580 Artificial Intelligence (4)

Current research in the field of artificial intelligence with emphasis on cooperative agents, distributed agents, and decision making in complex, concurrent environments. AI programming in a distributed environment. 3 lectures, 1 laboratory. Prerequisite: CPE 481. *Crosslisted as CPE/CSC 580.*

CPE 581 Computer Support for Knowledge Management (4)

Use methods and techniques that computer-based systems can provide to make the management of knowledge and information in digital form easier for the user. Emphasis on support for knowledge-intensive activities performed by users. 3 lectures, 1 laboratory. Prerequisite: CSC/CPE 481. *Crosslisted as CPE/CSC 581.*