Computer Science Course Listing (as of 4.29.2009)

CAP 4053 ECS-CS 3(3,0)
AI for Game Programming: PR: CS Foundation Exam or EEL 4851C or C.I. Surveys cutting-edge AI techniques for video games and board games and contrasts them with more traditional approaches. *Spring.*

CAP 4104 ECS-CS 3(3,0)
Human and Technology Interaction: PR: COP 3330 and COP 3502C. Perceptual, cognitive, affective, social, organizational, commercial, and cultural factors. Disciplines, techniques and methodologies. Web, mobiles, and wearables. Embodied conversational agents. Elderly, disabled and special needs. *Fall.*

CAP 4453 ECS-CS 3(3,0)
Robot Vision: PR: COP 3503C and MAC 2312, or C.I. Perspective and orthographic projections; the processing of edges, regions, motion, shading, texture, object detection, recognition, and machine learning. *Fall, Spring.*

CAP 4630 ECS-CS 3(3,0)
Artificial Intelligence: PR: COP 3503C and COT 3960. Current methods in Al: knowledge-based systems, representation, inference, planning, natural language. Programming in Lisp or Prolog required. *Fall.*

CAP 4720 ECS-CS 3(3,0)
Computer Graphics: PR: COP 3503C and COT 3960 and MAC 2147 or equivolent. Math for computer graphics, visibility and shading, graphics and data structure, curves and surfaces, commodity graphics hardware, and graphics API. *Occasional.*

CAP 5015 ECS-CS 3(3,0)
Multimedia Compression on the Internet: PR: Seniors and graduate students with interest in internet technology. Multimedia data; internet technology; entropy; compression methods; lossy compression; vector quantization; transform coding; wavelet video compression; model based compression. *Occasional.*

CAP 5055 ECS-CS 3(3,0)
AI for Game Programming: PR: CS Foundation Exam or EEL 4851C or C.I. Surveys cutting-edge AI techniques for video games and board games and contrasts them with more traditional approaches. *Spring.*

CAP 5066 ECS-CS 3(3,0)
Web Application Authoring Tools: PR: Graduate standing and/or approval of the Director of the Software Engineering Certificate Program. A survey of available tools for creating and maintaining Web sites, and methodologies for; determining which tool is best suited for a particular application environment. *Fall.*

CAP 5100 ECS-CS 3(3,0)
Human-Computer Interface Design: PR: COP 4331C, graduate standing and/or approval of the Director of the Software Engineering Certificate Program. Focuses on dynamics of human-computer interaction. Provides a comprehensive overview of HCI design as a software discipline. Features a user-centered approach to Web-based application design. *Fall.*

CAP 5415 ECS-CS 3(3,0)
Computer Vision: PR: COP 3503C, MAC 2312 and COT 3960. Image formation, binary vision, region growing and edge detection, shape representation, dynamic scene analysis, texture, stereo and range images, and knowledge representation. *Fall.*

CAP 5419 ECS-CS 3(3,0)
3D Computer Vision: PR: C.I. 2D/3D Projective Geometry, Projective Transformation Estimation, Camera Calibration, Single View Modeling, Bi-focal Modeling, Fundamental Matrix, Stratified Structure, Homography, Tri-focal Tensor, Auto-Calibration, Cheirality. *Occasional.*

CAP 5510 ECS-CS 3(3,0)
Bioinformatics: PR: Background in programing language or molecular biology. This course introduces problems, concepts, algorithms, and applications in Bioinformatics. It covers essential topics such as sequence alignment and prediction of gene and protein structure. *Occasional.*

CAP 5512 ECS-CS 3(3,0)
Evolutionary Computation: PR: CAP 4630 or C.I. This course covers the field of evolutionary computation, focusing on the theory and application of genetic algorithms. *Spring.*

CAP 5610 ECS-CS 3(3,0)
Machine Learning: PR: CAP 4630 or C.I. Origin/evaluation of machine intelligence; machine learning concepts and their applications in problem solving, planning and "expert systems" symbolic role of human and computers. *Occasional.*

CAP 5636 ECS-CS 3(3,0)
Advanced Artificial Intelligence: PR: CAP 4630. Al theory of knowledge representation, "expert systems", memory organization, problem solving, learning, planning, vision, and natural language. *Fall.*

CAP 5725 ECS-CS 3(3,0)
Computer Graphics I: Architecture of graphics processors; display hardware; principles of programming and display software; problems and applications of graphic systems. *Spring.*

CAP 6065 ECS-CS 3(3,0)
Planning and Estimating Web Application Development: PR: DIG 3134C or CET 4583, CIS 5378, COP 6717, graduate standing and/or approval or the Direcotr of the Software Engineering Certificate Program. Web project manager responsibilities. Team assembly and communication. Project definition, change management, planning strategies and workflow. Design, build and delivery stages. Quality Assurance. Agile methodologies. *Occasional.*

CAP 6105 ECS-CS 3(3,0)
Pen-Based User Interfaces: PR: CAP 5610 or C.I. Designed to give students a thorough understanding of the techniques, algorithms, and evaluation methodologies used in designing and developing pen-, sketch-, and gesture-based user interfaces. *Fall.*

CAP 6133 ECS-CS 3(3,0)

Advanced Topics in Computer Security and Computer Forensics: PR: COP 5611, COT 5405, CNT 5008. Advanced topics in computer security and forensics such as cryptography; automatic instrusion detection, advanced pattern matching, statistical techniques, firewalls, and vulnerability scanning. *Occasional.*

CAP 6135 ECS-CS 3(3,0)
Malware and Software Vulnerability Analysis: PR: CNT 4704 or equivalent and CGS 5131, or C.I. Analyzes computer malicious codes, such as virus, worm, trojan, spyware, and software vulnerabilities, such as buffer-overflow. *Even Fall.*

CAP 6411 ECS-CS 3(3,0)
Computer Vision Systems: PR: CAP 5415. Recent systems contributing toward recognition, reasoning, knowledge representation, navigation, and dynamic scene analysis. Comparisons, enhancements, and integrations of such systems. *Occasional.*

CAP 6412 ECS-CS 3(3,0)
Advanced Computer Vision: PR: CAP 5415. Computational theories of perception, shape from IX' techniques, multi-resolution image analysis, 3-D model based vision, perceptual organization, spatiotemporal model, knowledge-based vision systems. *Occasional.*

CAP 6545 ECS-CS 3(3,0)
Machine Learning Methods for Bioinformatics: PR: CAP 5510 or C.I. Machine learning methods and their applications in Bioinformatics. *Occasional.*

CAP 6616 ECS-CS 3(3,0)
Neuroevolution and Generative and Developmental Systems: PR: COP 3503C or C.I. Focuses on evolving neural networks for difficult sequential decision and control tasks and associated issues in efficient encoding and representation. *Occasional.*

CAP 6637 ECS-CS 3(3,0)
Activity and Plan Recognition: PR: CAP 5415 or CAP 5610 or CAP 5512 or C.I. Classical and probabilistic techniques for plan and activity recognition with a focus on graphical models. *Odd Fall.*

CAP 6640 ECS-CS 3(3,0)
Computer Understanding of Natural Language: PR: CAP 5636. A study of the different approaches to build programs to understand natural language. The theory of parsing, knowledge representation, memory, and inference will be studied. *Spring.*

CAP 6671 ECS-CS 3(3,0)
Intelligent Systems: Robots, Agents, and Humans: PR: CAP 5610 or C.I. Includes practical techniques for designing intelligent agents capable of planning, learning, and cooperation. Discussion of psychological/social issues. *Spring.*

CAP 6675 ECS-CS 3(3,0)

Complex Adaptive Systems: PR: Graduate standing or C.I. This course is an introduction to the field of complex adaptive systems and will cover basic definitions, theoretical background, and empirical analyses. *Fall.*

CAP 6676 ECS-CS 3(3,0)
Knowledge Representation: PR: CAP 5636. Topics covered include terminological languages, logicist approaches, ontologies, ontological and conceptual relativity, processes, intangibles, time, building large knowledge bases, and complexity analysis. *Occasional.*

CAP 6701 ECS-CS 3(3,0)
Real-time Realistic Rendering: PR: CAP 4720 or CAP 5725. GPU Programming; State-of-the-art algorithms for: Real-time rendering of a lighting effects and realistic materials; Real-time volume rendering; real-time simulation and rendering of smoke. *Occasional.*

CAP 6721 ECS-CS 3(3,0)
Ray Tracing: PR: CAP 5725, programming experience. Advanced graphics: Implementation of ray tracing algorithm plus extensions, spatial subdivisions, MC sampling, camera models, texture mapping, instancing. *Occasional.*

CAP 6835 ECS-CS 3(3,0)
Visual Simulation, Rendering, and Photometry: PR: CAP 5415. Modeling: SFM, space carving, voxel coloring; Image-based rendering: morphing, plenoptic resampling, lumigraph, layered 2.5D representation; image-based photometry: light, color constancy, BRDF, intrinsic images, invariants. *Occasional.*

CDA 3103 ECS-CS 3(3,0)
Computer Organization: PR: COP 3223. Logic design, computer arithmetic, Instruction Set Architecture (MIPS, SPIM simulator), performance, data path, control unit, memory hierarchy, I/O interface. *Occasional.*

CDA 4150H ECS-CS 4(3,1)
Honors Computer Architecture: PR: Consent of Honors and COP 3402 and CDA 3103C. Basic processor design, hardwired and microprogrammed control, ALU, memory organization, pipelining, I/O and computer arithmetic. With Honors level content. *Occasional.*

CDA 5106 ECS-CS 3(3,0)
Advanced Computer Architecture: PR: EEL 4768C. Modern processor design, instruction-level parallelism, thread-level parallelism, data-level parallelism, memory hierarchy, and I/O. *Fall, Spring.*

CDA 5110 ECS-CS 3(3,0)
Parallel Architecture and Algorithms: PR: COT 4210, CDA 5106. General-purpose vs. special-purpose parallel computers; arrays, message-passing; shared-memory; taxonomy; parallization techniques; communication synchronization and granularity; parallel data structures; automatic program restructing. *Occasional.*

CDA 5215 ECS-CS 3(3,0)
Architecture and Design of VLSI: PR: EEL 4768C. Overview of VLSI technology. Logical design of basic subsystems; integrated system design tools; design of a VLSI computer system. *Occasional.*

CDA 5530 ECS-CS 3(3,0)
Performance Models of Computers and Networks: PR: Senior standing or beginning graduate student. Performance Models of Computer Systems and Networks using probability models and discrete event simulations. Queuing Theory and modeling tools. *Occasional.*

CDA 5532 ECS-CS 3(3,0)
Network-Centric Computing: PR: Graduate standing. Concepts in network-centric computing and process coordination in information grids. *Occasional.*

CDA 6107 ECS-CS 3(3,0)
Parallel Computer Architecture: PR: CDA 5106. Principles and trade-offs in the design of parallel architectures, shared-memory, message-passing, dataflow, data-parallel machines, cache coherence protocols, and consistence models. *Spring.*

CDA 6211 ECS-CS 3(3,0)
VLSI Algorithms and Architecture: PR: CDA 5215. VLSI algorithms, algorithms on regular geometries, hierarchically organized machines; illustrative algorithms: Matrix, DFT, recurrence evaluation, pattern matching, searching, sorting, graph, etc.; area-time complexity issues. *Occasional.*

CEN 4020 ECS-CS 3(3,0)
Component-based Engineering Software: PR: EEL 4851C, EEL 4882. In-depth treatment of component-based software development including analysis design and implementation of correct and reausable software in different component levels. *Occasional.*

CEN 5016 ECS-CS 3(3,0)
Software Engineering: PR: COP 4331C. Application of formal software processes, engineering methods, and documentation standards to the development of large scale software systems. A team project is required. *Spring.*

CEN 5077 ECS-CS 3(3,0)
Web Application Testing: PR: Graduate standing and/or approval of the Director of the Software Engineering Certificate Program. Test design strategies, patterns and tools. Metrics. Client-server and wireless applications testing. Automated testing. Quality assurance. Performance, security, and usability analysis. Cross site scripting tests. *Summer.*

CEN 5326 ECS-CS 3(3,0)
Web Server Configuration and Maintenance: PR: COP 3502C, CNT 3004, graduate standing and/or approval of the Director of the Software Engineering Certificate Program. Offers a comprehensive overview of the tools and techniques needed to succeed as a Web Server Administrator, including the tasks they are expected to perform. *Occasional.*

CEN 6036 ECS-CS 3(3,0)
Web Application Architecture and Design: PR: COP 4331C, CIS 5378, COP 6717, graduate standing and/or approval of the Director of Software Engineering Certificate Program. Software, web, security, information,

messaging, and deployment architecture. Architecture views. Architecture patterns. Design patterns. UML and RUP methodologies. *Summer.*

CEN 6081 ECS-CS 3(3,0)
Engineering Software Design in Distributed and Parallel Systems: PR: EEL 4882 and EEL 4884C or EEL 5881. This course will focus on engineering software design, implementation, configuration and performance evaluation of distributed and parallel systems. *Occasional.*

CET 4741L ECS-CS 3(0,3)
Computer Networking Laboratory: PR: C.I. Laboratory exercises to enhance the understanding of concepts/principles discussed in computer networking and data communication texts. *Occasional.*

CGS 1060C ECS-CS 3(2,2)
Introduction to Computer Science: History, typical computer, number systems, control and data flow, peripheral components, memory devices, effects of computers on society, applications of computers. Not open to Computer Science Majors. *Fall, Spring, Summer.* M&S fee: $15.00

CGS 1060H ECS-CS 3(2,2)
Honors Introduction to Computer Science: PR: Permission of Honors. History, number systems, control and data flow, peripheral components, memory devices, effects of computers on society, applications of computers. Not open to Computer Science Majors. *Occasional.* M&S fee: $15.00

CGS 2100C ECS-CS 3(2,1)
Computer Fundamentals for Business: Uses of computers and software in business, including business applications, commercial packages, and the internet. Not open to Computer Science majors. *Fall, Spring, Summer.* M&S fee: $15.00

CGS 2545C ECS-CS 3(2,1)
Database Concepts: PR: CGS 1060C or equivalent. Entity-relation model, relational database managements systems, normal forms, performance or databases, report generation. *Fall, Spring.*

CGS 2585C ECS-CS 3(2,1)
Desktop/Internet Publishing: PR: CGS 1060C or equivalent. Principles and techniques of page layout and formatting for documents and newsletters, presentation techniques, construction of web pages and design of integrated websites. *Occasional.*

CGS 3175 ECS-CS 3(3,0)
Internet Applications: PR: CGS 1060C. HTML coding, using images, sound and animation, advanced text formatting, forms and CGS scripts, introduction to javascript. *Fall, Spring.*

CGS 3269 ECS-CS 3(3,0)
Computer Architecture Concepts: PR: CGS 1060C. CPU organization, current computer architectures, network file servers. *Fall, Spring.*

CGS 3763 ECS-CS 3(3,0)
Operating System Concepts: PR: CGS 1060C. System calls, concept of processes, CPU scheduling, security issues, client server paradigms, and computer supported workgroups. *Occasional.*

CGS 4144 ECS-CS 3(3,0)
Introduction to Informatics: PR: CGS 3175 and HIM 3006. Computers and mechanical intelligence. The information society. Social and information networks. Technology and its applications. Information organization and structure. Human behavior and communication. *Occasional.*

CGS 5131 ECS-CS 3(3,0)
Computer Forensics I: Seizure and Examination of Computer Systems: PR: Computer literacy and C.I. Legal issues regarding seizure and chain of custody. Technical issues in acquiring computer evidence. Popular file systems are examined. Reporting issues in the legal system. *Fall.*

CGS 5132 ECS-CS 3(3,0)
Computer Forensics II:Network Security, Intrusion Detection, & Forensic Analysis: PR: CGS 5131. Computer network protocals and security, network intrusion detection and prevention, digital evidence collection and evaluation, and legal issues involed in network forensics analysis. *Spring.*

CIS 3003 ECS-CS 3(3,0)
Fundamentals of Information Technology: PR: CGS 2545C and COP 3223. Pervasive themes in IT. Organizational issues. History of IT. IT and its related and informing disciplines. Application domains. Applications of math and statistics to IT. *Fall.*

CIS 3360 ECS-CS 3(3,0)
Security in Computing: PR: COP 3223 or EGN 3211 or CET 2364. Security theory. Legal and human factors, Malware, Intrusion patterns and tools, Windows, Unix, TCP/IP, and applications vulnerabilities. Detection. Policies and enforcement. Protection and assurance. *Occasional.*

CIS 3362 ECS-CS 3(3,0)
Cryptography and Information Security: PR: COP 3223 or EGN 3211 or CET 2364, and MAC 2147 or equivalent. Encryption algorithms and ciphers. Public and private keys. Key infrastructures. Authentication, confidentiality, integrity, and nonrepudiation. Digital signatures and certificates. Hash and digest algorithms. Standards. *Occasional.*

CIS 4004 ECS-CS 3(3,0)
Web-Based Information Technology: PR: CNT 3004 anf COP 3330. Digital libraries. Media formats. Compression. Streaming Media. Mobile internet and WML. Emerging technologies. Capacity planning for web services. *Fall, Spring.*

CIS 4313 ECS-CS 3(3,0)
Managing IT Integration: PR: CIS 3003. Requirements, acquisition and sourcing. Integration. Project management. Testing and QA. Organizational context. Architecture. *Spring.*

CIS 4361 ECS-CS 3(3,0)
Secure Operating Systems and Administration: PR: COP 4600 or CGS 3763. Understanding of secure operating systems requirements, design principles and theories, protection methods, access control, authentication, vulnerability, analysis and case studies. *Occasional.*

CIS 4615 ECS-CS 3(3,0)
Secure Software Development and Assurance: PR: (COP 4600 or CGS 3763) and (CIS 3360 or CIS 3362) or C.I. Thread modeling, Secure code life-cycle, Buffer overflows, race conditions and format string problems, Inputs and clients, File system, Cryptography applications, UMLsec, Java security and Reverse engineering. *Occasional.*

CIS 5105 ECS-CS 3(3,0)
Capacity Planning and Performance Evaluation of Web Services: PR: COP 4600, graduate standing and/or approval of the Director of the Software Engineering Certificate Program. Web performance problems, basic performance concepts, quantitative models for web performance, planning the capacity of web services, understanding and characterizing the workload, measuring performance. *Occasional.*

CIS 5378 ECS-CS 3(3,0)
Designing Secure Transactions in Web Applications: PR: Graduate standing and/or approval of the Director of the Software Engineering Certificate Program. Secure electronic commerce, data indirection, shell command injection, cross-site scripting, Web Trojans, symmetric encryption, security protocols, application vulnerabilities, threats and hackers. *Spring.*

CIS 6611 ECS-CS 3(3,0)
Software Engineering II: . *Occasional.*

CNT 3004 ECS-CS 3(3,0)
Computer Network Concepts: PR: CGS 1060C, EEL 3041. Network media, protocol, current and evolving standards for local, metropolitan, wide area and wireless networks. *Fall, Spring.*

CNT 4403 ECS-CS 3(3,0)
Network Security and Privacy: PR: (CNT 3004 or CET 4483 or CNT 4704) and (CIS 3360 or CIS 3362) or C.I. Fundamentals of network security, protocols, secure applications, network intrusion detection, security policy, firewalls, and privacy issues. *Occasional.*

CNT 4703C ECS-CS 3(1,2)
Design and Implementation of Computer Communication Networks: PR: CNT 3004, COP 3502C, MAD 2104 or COT 3100C. Data communication networking technologies (TCP/IP, Ethernet, Gigabit Ethernet, ATM, Frame Relay), products (routers, switches, adapters, cabling). Base design and detailed configuration including hands-on exercises. *Fall, Spring.* M&S fee: $16.00

CNT 4704 ECS-CS 3(3,0)
Analysis of Computer Communication Networks: PR: COT 3100C, STA 2023, MAC 2312. Network design using layering. Introduces cabling, topology, architecture, hardware and software. Includes performance and control issues such as congestion control, error control, contention resolution. *Occasional.*

CNT 4714 ECS-CS 3(3,0)
Enterprise Computing: PR: CGS 3269, MAD 2104, COP 3330 and COP 3502C. Client-server architecture. Server-side scripting: Servlets, JSP, PHP. JDBC and MySQL database; connectivity. Multi-threaded Java applications. J2EE development. SSL., Event-driven programming. *Fall, Spring.*

CNT 5008 ECS-CS 3(3,0)
Computer Communication Networks Architecture: PR: EEL 4768C. Computer networks, layers, protocols and interfaces, local area networks networking. *Fall.*

CNT 6519 ECS-CS 3(3,0)
Wireless Security and Forensics: PR: CGS 5131 or C.I. Advanced topics in wireless network security, security management, cryptography, wireless forensics and related areas. *Odd Spring.*

CNT 6707 ECS-CS 3(3,0)
Advanced Computer Networks: PR: CNT 5008 or C.I. Recent advances in computer networks, overlay and multihomed networks, routing and multicasting, Internet friendly protocols, congestion control, QoS-differentiated services, cellular networks. *Spring.*

COP 2500C ECS-CS 4(3,1)
Concepts in Computer Science: Fundamental concepts in program design, data structures, algorithms, analysis and a survey of topics in CS. Not open to Computer Science majors. *Fall, Spring, Summer.*

COP 3223 ECS-CS 3(3,0)
Introduction to Programming with C: Equivalent to EGN 3211. Programming in C including arrays, pointer manipulation and use of standard C math and IO libraries. *Fall, Spring, Summer.*

COP 3330 ECS-CS 3(3,0)
Object Oriented Programming: PR: COP 3223. Object oriented programming concepts (classes, objects, methods, encapsulating, inheritance, interfaces) and the expression of these concepts in the programming languages such as JAVA. *Fall, Spring, Summer.*

COP 3402 ECS-CS 3(3,0)
Systems Software: PR: COP 3502C. Design and development of assemblers, linkers, loaders, and compilers. Study memory hierarchy, program performance, and system level I/O. *Fall, Spring, Summer.*

COP 3502C ECS-CS 3(3,0)
Computer Science I: PR: COP 3223 and MAC 1105. Problem solving techniques, order analysis and notation, abstract data types, and recursion. *Fall, Spring, Summer.*

COP 3502H ECS-CS 3(3,0)
Honors Computer Science I: PR: Permission of Honors and COP 3223 and MAC 1105. Problem solving techniques, order analysis and notation, abstract data types, and recursion. *Occasional.*

COP 3503C ECS-CS 4(3,1)
Computer Science II: PR: COP 3502C and COT 3100C and (MAD 2104 and COP 3330). Algorithm design and analysis for tree, list, set, and graph data models; algorithmic strategies and applications, and algorithmic complexity analysis; sorting and searching; practical applications. *Fall, Spring, Summer.*

COP 3503H ECS-CS 4(3,1)
Honors Computer Science II: PR: Permission of Honors and (COP 3502H or COP 3502C) and COP 3330 and (MAD 2104 or COT 3100C). Algorithm design and analysis for tree, list, set, and graph data models; algorithmic strategies and applications, and algorithmic complexity analysis; sorting and searching; practical applications. With honors content. *Fall.*

COP 4020 ECS-CS 3(3,0)
Programming Languages I: PR: COP 3503C and COT 3960. Paradigms and fundamental concepts of programming languages are presented, including: scope, binding, abstraction, encapsulation, typing etc. Design paradigms object-oriented, functional and logic programming are presented. *Fall, Spring, Summer.*

COP 4331C ECS-CS 4(3,1)
Processes for Object-Oriented Software Development: PR: COP 3502C, COP 3330, COT 3960 (Foundation Exam - for Computer Science students). Concepts, principles, processes and methods for developing large software systems featuring a team project using object-oriented design in UML and implementation in C++. *Occasional.*

COP 4516C ECS-CS 3(1,3)
Problem Solving Techniques and Team Dynamics: PR: COP 3503C. Design and implement solutions to problems requiring the applications of the different algorithms. Team project format. *Occasional.*

COP 4520 ECS-CS 3(3,0)
Concepts of Parallel and Distributed Processing: PR: COP 3402 and COP 3503C and COT 3960. Parallel and distributed paradigms, architectures and algoriyhms, and the analytical tools, environments and languages needed to support these paradigms. *Occasional.*

COP 4600 ECS-CS 3(3,0)
Operating Systems: PR: COP 3402 and COP 3503C and COT 3960 for Computer Science students. Function and organization of operating systems, process management, virtual memory, I/O management, and file management. *Fall, Spring, Summer.*

COP 4610L ECS-CS 3(0,3)
Operating Systems Laboratory: PR: COP 3502C. Exercises in the configuration, development, management and analysis of operating systems; OS Kernel support for semaphores and multi-tasking; security in a distributed heterogeneous environment. *Fall, Spring.*

COP 4710 ECS-CS 3(3,0)
Database Systems: PR: COP 3503C. Storage and access Structures, database models and languages, related database design, and implementation techniques for database management systems. *Fall, Spring.*

COP 4910 ECS-CS 3(3,0)
Frontiers in Information Technology: PR: COP 4610L or CNT 4703C. Research into leading edge information technologies that have a high likelihood of affecting the work place in the two to five year time frame. *Spring.*

COP 5021 ECS-CS 3(3,0)
Program Analysis: PR: COP 4020 and COT 4210 or C.I. Static analysis of programs including theoretical and practical limitations, data flow analysis, abstract interpretation, and ype and effect systems. Tools to automate program analysis. *Even Spring.*

COP 5537 ECS-CS 3(3,0)
Network Optimization: PR: Graduate standing or C.I. Techniques for modeling complex, interconnected systems as networks; optimization with graph theory; algorithms, data structures, and computational complexity; statistical methods for studying large, evolving networks. *Fall.*

COP 5611 ECS-CS 3(3,0)
Operating Systems Design Principles: PR: COP 4600. Structure and functions of operating systems, process communication techniques, high-level concurrent programming, virtual memory systems, elementary queuing theory, security, distributed systems, case studies. *Spring.*

COP 5711 ECS-CS 3(3,0)
Parallel and Distributed Database Systems: PR: COP 4710. Storage manager, implementation techniques for parallel DBMSs, distributed DBMS architectures, distributed database design, query processing, multidatabase systems. *Occasional.*

COP 6525 ECS-CS 3(3,0)
Distributed Processing of Digital Evidence: PR: CGS 5131 and COP 5611, or C.I. Parallel and distributed processing techniques using MPI in a cluster environment; data mining techniques used in analyzing large quantities of digital data. *Even Spring.*

COP 6614 ECS-CS 3(3,0)
Operating Systems Techniques: PR: COP 5611. Techniques in the design and implementation of operating systems. Case studies of several experimental and commercial operating systems. *Occasional.*

COP 6615 ECS-CS 3(3,0)
Operating Systems Theory: PR: COP 5611. Scheduling and queuing theory, simulation, and performance evaluation of computer systems. *Occasional.*

COP 6621 ECS-CS 3(3,0)
Compiler Construction: PR: COP 5021, COT 5310. Techniques in the design and implementation of compilers. Optimization, code generation, error recovery, attributed grammars. A project is required. *Occasional.*

COP 6717 ECS-CS 3(3,0)
Database Interface Development: PR: COP 4710, CAP 5066, graduate standing and/or approval of the Director of the Software Engineering Certificate Program. Design and implementation techniques for incorporating database

interfaces in Web applications. Comparison of tools and methodologies, including Microsoft .NET, Java JDBC, and PHP. Hands-on exercises. *Spring.*

COP 6730 ECS-CS 3(3,0)
Transaction Processing: PR: COP 4710. Transaction models, transaction monitors, isolation concepts and lock manager implementation, log manager, transaction manager, file and buffer management, client-server computing. *Occasional.*

COP 6731 ECS-CS 3(3,0)
Advanced Database Systems: PR: COP 5711. Selected topics concerning object-oriented databases, multimedia databases, active databases, temporal databases, spatial databases, and information systems. *Occasional.*

COT 3100C ECS-CS 3(3,1)
Introduction to Discrete Structures: PR: MAC 1105, MAC 1114. Logic, sets, functions, relations, combinatorics, graphics, Boolean algebras, finite-state machines, Turing machines, unsolvability, computational complexity. *Fall, Spring, Summer.*

COT 3100H ECS-CS 3(3,0)
Honors Introduction to Discrete Structures: PR: Permission of Honors and MAC 1105, MAC 1114. Logic, sets, functions, relations, combinatorics, graphics, Boolean algebras, finite-state machines, Turing machines, unsolvability, computational complexity. *Occasional.*

COT 3960 ECS-CS 0(1,0)
CS Foundation Exam: PR: COP 3502C AND COT 3100C. Foundation examination for computer science majors. Required before taking advanced core courses in Computer Science and upper-division 4000 and 5000 level CS electives. Graded S/U. *Fall, Spring, Summer.*

COT 4210 ECS-CS 3(3,0)
Discrete Structures II: PR: COP 3503C and COT 3960. Computation Theory. A study of the properties of grammars and automata as formal specifications for algorithms and families of languages. *Fall, Spring, Summer.*

COT 4400 ECS-CS 3(3,0)
Tools for Algorithm Analysis: PR: COT 3960 and COP 3503C. Tools from discrete and continuous mathematics for analyzing complexity of algorithms. Order notation use and manipulation. *Occasional.*

COT 4500 ECS-CS 3(3,0)
Numerical Calculus: PR: MAC 2312 and COP 3502C. Numerical methods for finding roots of nonlinear equations, solutions of systems of linear equations, and ordinary differential equations. *Occasional.*

COT 4810 ECS-CS 3(3,0)
Topics in Computer Science: PR: COP 3402 and COP 3503C and COT 3960. A range of topics from the field of Computer science; application of oral and written communication skills; social, ethical and moral issues of computing. *Fall, Spring, Summer.*

COT 5310 ECS-CS 3(3,0)
Formal Languages and Automata Theory: PR: COP 4020 and COT 4210. Classes of formal grammars and their relation to automata, normal forms, closure properties, decision problems. LR(K) grammars. *Fall, Spring.*

COT 5405 ECS-CS 3(3,0)
Design and Analysis of Algorithms: PR: COT 4210. Classification of algorithms, e.g., recursive, divide-and-conquer, greedy, etc. Data Structures and algorithm design and performance. Time and space complexity analysis. *Fall, Spring.*

COT 5507 ECS-CS 3(3,0)
Computational Methods/Applications: PR: COT 4500. Computational solution techniques for algebraic equations, ODE and PDE Models of applications selected from science, engineering, applied mathematics, and computer science. *Occasional.*

COT 5510 ECS-CS 3(3,0)
Computational Methods/Linear Systems: PR: COT 4500 and MAS 3106. Mathematical models for linear systems, linear programming, the simplex method, integer and mixed-integer programming, introduction to nonlinear optimization and linearization. *Occasional.*

COT 5520 ECS-CS 3(3,0)
Computational Geometry: CR: COT 5405. Geometric searching, point location, convex hulls, proximity problems, Vononoi diagrams, spanning trees, triangulation, intersection arrangement applications. *Occasional.*

COT 6300 ECS-CS 3(3,0)
The Theory of Parsing and Translation: PR: COT 5310. Methods of top-down and bottom-up parsing, LL(k), recursive descent, precedence, bounded-context, SR(s,k), SLR(k), LALR(k), LR(k), parser compression and generation. *Occasional.*

COT 6410 ECS-CS 3(3,0)
Computational Complexity: PR: COT 5405. Properties of algorithms, computational equivalence of machines, time-space complexity measures, examples of algorithms of different complexity, classification of algorithms, classes P and NP. *Occasional.*

COT 6415 ECS-CS 3(3,0)
Complexity of Parallel Computation: PR: CDA 5110, COT 6410. Theoretical models justification and buildability inherent parallelism and communication costs. Lower and upper complexity bounds. Parallel computation thesis. NC, SC classes; paradigms of parallel algorithms. *Occasional.*

COT 6417 ECS-CS 3(3,0)
Algorithms on Strings and Sequences: PR: COT 5405 or C.I. Study of algorithms for exact and approximate string pattern matching, sequence alignment and multiple string alignment. *Occasional.*

COT 6505 ECS-CS 3(3,0)

Computational Methods/Analysis I: PR: COT 5510. Analysis of direct and iterative solutions of systems of linear equations, eigenvalues and vectors and roots of nonlinear equations, error analysis. *Occasional.*

COT 6602 ECS-CS 3(3,0)
Introduction to Quantum Information Theory: PR: COT 6600 Quantum Computing. Basic concepts in quantum information theory and quantum error correcting codes. *Occasional.*

DIG 4645 ECS-CS 3(3,0)
Digital Media: PR: COP 3503C or C.I. Information structures, algorithms and interactive tools for creation, compression, storage, indexing and transmission of multimedia (visual images, sound, tactile displays, etc.) Project-oriented. *Occasional.*

DIG 4770 ECS-CS 3(3,0)
Building Virtual Worlds: PR: COP 3503C or C.I. Design and construction of software for networked interactive learning environments, entertainment and communication systems. Tools for enabling dramatic, artistic and technical creativity. Project oriented. *Occasional.*

CAP 6121 ECS-EECS 3(3,0)
3D User Interfaces for Games and Virtual Reality: PR: CAP 5725 or C.I. Introduction to the design, implementation, and evaluation of the fundamental techniques in spatial 3D interaction. *Spring.*