Academic and Curriculum Policies

Restricted Electives - These credit hours are included in the curriculum with the intent to enhance the technical skills and knowledge of the student. Students may choose to select restricted electives in a single area of computer science or information technology to advance their understanding of a particular area or technology; or they may choose to take coursework in a diversity of technical areas to give both breadth and depth to more than one area of interest. It is highly recommended that students talk to an advisor before registering for an elective.

Courses that are considered professional development in content are not accepted as restricted electives. For professional development in areas of business or management, the Engineering Leadership minor or a business minor should be considered.

Restrictions on electives:

- Accepted restricted elective courses consist of any 4000-4899 Computer Science Department courses, that are not already a required course for the degree - **EXCEPT CIS4340 and ISC4551 (for both CS/IT majors) and COP 4283 (for CS major)**. Please note that to enroll on these courses, prerequisites must be satisfied.
- Courses at the 3000-level, taught by the CS Department, that are not already a required course for the degree, will be accepted as restricted electives for Information Technology students only. Except for CIS 3362, which also counts as a CS tech elective.
- 5000-5899 graduate courses may be used as restricted electives. To take a graduate course as an undergraduate student, the following requirements must be met:
    - Passed Computer Science Foundation Exam.
    - A UCF GPA of 3.0 or higher at the time of registration.
    - Completed COP3503 with a B grade or better.
    - A “B” grade or better is required in every catalog prerequisite for the graduate course.
    - May take no more than 2 graduate courses per semester.
    - May not take a 6000-level course until final graduating term and must be taken with no more than 12 credit hours, including the 6000-level course.
    - Limited to 3 graduate courses, overall. BS to MS students may take up to 4 courses.
- ** *Only one of the following seven IT courses may count towards CS Restricted Electives: CIS4004, CIS4524, CNT4603, CNT4703, CNT4714, CAP4102, and (CAP4104, No longer offered).* The prerequisite for those IT courses is Computer Science II (COP3503), except CAP4102, which is Computer Science I (COP3502).
- Computer Science students with a UCF GPA of at least 3.00 at the time of registration, are allowed to enroll in three hours of Independent Study (IS) or Independent Research (IR), based on completion of the required agreement between the student and the faculty offering the IS or IR. Only CS Department faculty are permitted to supervise IS or IR hours for acceptance as restricted elective.
- Courses from the College of Sciences and/or other UCF colleges are not accepted as restricted electives. If a student has the desire to pursue additional coursework in an area such as mathematics or physics, a minor should be considered.
- Credit awarded for military, commercial, or private training will not be accepted as restricted elective hours. Internships are accepted as one restricted elective for IT students ONLY, through the IT internship program: http://server.cs.ucf.edu/itinternship/.
- New courses are introduced often. Students interested on a new course that is not listed on this document, please inquire by contacting the CS Department advising office (HEC 346).

Program	Course
CS Elective Course IT Elective Course	**CAP 4053 ECS-CS 3(3,0) AI for Game Programming:** PR: COP 3502C with a grade of "C" (2.0) or better or C.I. Surveys cutting-edge AI techniquesfor video games and board games and contrasts them with more traditional approaches. *Fall, Spring.*
** CS Elective Course (This is an IT course; only one IT course is allowed as CS elective) IT Elective Course	**CAP 4102 ECS-EECS 3(3,0) IT Design and User Experience**: PR: COP3502C with a grade of "C" (2.0) or better. To meet a real world customer's needs, student teams will learn and apply user-centered principles to elicit requirements, prototype, and build a complete web-based solution. *Fall.*
CS Elective Course IT Elective Course	**CAP 4145 ECS-CS 3(3,0) Introduction to Malware Analysis:** PR: CIS 3360, (CGS 3269 or CDA 3103C), (CGS 3763 or COP 4600), or C.I. Introduction to using reverse engineering techniques to find and analyze the behavior of programs in binary form; assembly language, reverse engineering tools, and virtual machines. *Spring.*
CS Elective Course IT Elective Course	**CAP 4314 ECS-CS 3(3,0) Social Network Analysis:** PR: CNT 3004 and COP 3330. COP3503 for CS major students. Introduce the concept of social network. Network structure and measures. Network visualization. Tie strength and propagation in networks. Methods for social network analysis (SNA). Public sector applications of SNA. Business applications of SNA. *Fall.*
CS Elective Course IT Elective Course	**CAP 4453 ECS-CS 3(3,0) Robot Vision:** PR: COP 3503C and MAC 2312 each with a grade of "C" (2.0) or better or C.I. Perspective and orthographic projections; the processing of edges, regions, motion, shading, texture, object detection, recognition, and machine learning. *Fall, Spring.*
CS Elective Course IT Elective Course	**CAP 4543 ENGR-COMP SCI 3(3,0) Introduction to Bioinformatics Algorithms:** PR: COP 3502C with a grade of "C" (2.0) or better. Introduce algorithmic ideas for addressing real-world biological questions, including brute-force search, greedy algorithms, dynamic programming, randomized algorithms, graph algorithms, clustering algorithms, etc. *Fall.*
CS Elective Course IT Elective Course	**CAP 4611 ECS-CS 3(3,0) Algorithms for Machine Learning:** PR: COP 3502C and STA 2023 each with a grade of C (2.0) or better. An overview of the most commonly used algorithms for supervised, unsupervised, and reinforcement learning. Introduction to experimental design, evaluation metrics, and applications of machine learning. *Fall, Spring.*
CS Elective Course IT Elective Course	**CAP 4630 ECS-CS 3(3,0) Artificial Intelligence:** PR: COP 3503C with a grade of "C" (2.0) or better and COT 3960. Current methods in AI: knowledge-based systems, representation, inference, planning, natural language. Programming in Lisp or Prolog required. *Fall, Spring.*
CS Elective Course IT Elective Course	**CAP 4641 ENGR-CS 3(3,0) Natural Language Processing:** PR: COP 3503C with a grade of "C" (2.0) or better and COT 3960. A study of techniques that allow computers to derive meaning from human language. Text processing basics, language modeling, parsing, summarization, conversational systems will be studied. *Occasional.*
CS Elective Course IT Elective Course	**CAP 4720 ECS-CS 3(3,0) Computer Graphics:** PR: COP 3503C and MAC 1114C each with a grade of "C" (2.0) or better, and COT 3960. Math for computer graphics, visibility and shading, graphics and data structure, curves and surfaces, commodity graphics hardware, and graphics API. *Fall.*

Program	Course
CS Elective Course IT Elective Course	**CAP 5115 ENGR 3(2,1) Virtual Reality Engineering:** PR: MAS 3105 or C.I. Virtual reality, scene graphs and computer graphics, development of travel, selection, manipulation, systemcontrol, animation-based, and physics-based interaction techniques, implementation of 360° videos. *Spring*.
CS Elective Course IT Elective Course	**CAP 5150 3(3,0) - Foundations of Computer Security and Privacy:** PR: None. However, students are expected to have knowledge equivalent to a BS in Computer Science. The courseprovides students with fundamental knowledge in computer security and privacy. *Fall*.
CS Elective Course IT Elective Course	**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 rangeimages, and knowledge representation. *Fall*.
CS Elective Course IT Elective Course	**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 topicssuch as sequence alignment and prediction of gene and protein structure. *Fall*.
CS Elective Course IT Elective Course	**CAP 5512 ECS-CS 3(3,0) Evolutionary Computation:** PR: CAP 4630 or COP 3503C or C.I. This course covers the field of evolutionary computation, focusing on the theory and application of genetic algorithms. *Spring*.
CS Elective Course IT Elective Course	**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. *Fall, Spring*.
CS Elective Course IT Elective Course	**CAP 5636 ECS-CS 3(3,0) Advanced Artificial Intelligence:** PR: CAP 4630. AI theory of knowledge representation, “expert systems”, memory organization, problem solving, learning, planning, vision, and natural language. *Fall*.
CS Elective Course IT Elective Course	**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*.
CS Elective Course IT Elective Course	**CAP 5738 ECS-EECS 3(3,0) Visualization Techniques for Data Analysis:** PR: COP 3330, COP 3502C. Techniques for visualization that are useful for analyzing and presenting quantitative information are covered. Projects analyze one or more real-world publicly available datasets. Understanding the data, visualizing it, creating hypotheses, and visually exploring them. Application of statistical techniques to test hypotheses about data trends and visualize how well their hypotheses match with their analysis. *Occasional*.
CS Required Course IT Elective Course (IT ONLY – or can substitute CGS 3269)	**CDA 3103C ECS-CS 3(3,1) Computer Logic and Organization:** PR: COP 3223C with a grade of “C” (2.0) or better. Logic design, computer arithmetic, Instruction Set Architecture (MIPS, SPIM simulator),performance, data path, control unit, memory hierarchy, I/O interface. *Fall, Spring*.

Program	Course
CS Elective Course IT Elective Course	**CDA 5106 ECS-CS 3(3,0) Advanced Computer Architecture:** PR: EEL 4768C. Modern processor design, instruction-level parallelism, thread- levelparallelism, data-level parallelism, memory hierarchy, and I/O. *Fall, Spring*.
CS Elective Course IT Elective Course	**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; parallelization techniques; communication synchronization and granularity; parallel data structures; automatic program restructuring. *Odd Spring*.
CS Elective Course IT Elective Course	**CEN 4360 ENGR-CS 3(3,0) Mobile Device Software Development:** PR: COP 3330 or C.I. Concepts and practice of software development for mobile devices. User interface, data persistence data communication, use of APIs for sound, mapping, GPS, sensors, etc. *Fall*.
CS Elective Course IT Elective Course	**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. *Occasional*.
IT Required Course	**CGS 2545C ECS-CS 3(2,1) Database Concepts:** PR: COP 2500C or high-level programming course (C, Java, C#, C++) with a grade of "C" (2.0) or better. Entity-relation model, relational database managements systems, normal forms, performance or databases, report generation. *Fall, Spring*.
IT Required Course	**CGS 3269 ECS-CS 3(3,0) Computer Architecture Concepts:** PR: COP 2500C or high-level programming course (C, Java, C#, C++) with a grade of "C" (2.0) or better. CPU organization, current computer architectures, network file servers. *Fall, Spring*.
IT Required Course	**CGS 3763 ECS-CS 3(3,0) Operating System Concepts:** PR: COP 2500C or high-level programming course (C, Java, C#, C++) with a grade of "C" (2.0) or better. System calls, concept of processes, CPU scheduling, security issues, client server paradigms, and computer supported workgroups. *Fall, Spring*.
IT Required Course	**CIS 3003 ENGR-CS 3(3,0) Fundamentals of Information Technology:** CR: Concurrently enrolled in COP 2500 or passing score on CPST exam. 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, Spring*.
CS Required Course IT Required Course	**CIS 3360 ECS-CS 3(3,0) Security in Computing:** PR: COP 3223C or EGN 3211 with a grade of "C" (2.0) or better. 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. *Fall, Spring*.

Program	Course
CS Elective Course IT Elective Course	**CIS 3362 ECS-ECE 3(3,0) Cryptography and Information Security:** PR: COP 3223C or EGN 3211, and MAC 1114C each with a grade of "C" (2.0) or better. Encryption algorithms and ciphers. Public and private keys. Key infrastructures. Authentication, confidentiality, integrity, and nonrepudiation. Digital signatures and certificates. Hash and digest algorithms. Standards. *Fall*. This is a CS Elective for catalog year 2017-2018 or later.
IT Required Course	**CIS 3921 ENGR-CS 1(1,0) Careers in IT:** PR: CIS 3990 and IT major. An overview of the IT field, job opportunities and careers in information technology, detailed information about some jobs as well as a broad survey. *Fall, Spring*.
IT Required Course	**CIS 3990 ENGR-CS 0(0,0) IT Career and Academic Advising I:** PR: COP 3223C and IT major. Mandatory meeting with students and their faculty advisor for career/academic advising. *Fall, Spring*.
** CS Elective Course (This is an IT course; only one IT course is allowed as CS elective) IT Required Course	**CIS 4004 ECS-CS 3(3,0) Web-Based Information Technology:** PR: CNT 3004 and COP 3330 each with grades of "C" (2.0) or better. Digital libraries. Media formats. Compression. Streaming Media. Mobile internet and WML. Emerging technologies. Capacity planning for web services. *Fall, Spring*.
CS Elective Course IT Elective Course	**CIS 4203C ECS-CS 3(2,2) Digital Forensics:** PR: (COP 4600 or CGS 3763) and (CIS 3360 or CIS 3362) or C.I. Operating system forensics, digital media forensics, networking forensics, various digital devices forensics. User activity profiling and digital storage recovery. *Fall*.
CS Elective Course IT Elective Course	**CIS 4361 ECS-CS 3(3,0) Secure Operating Systems and Administration:** PR: CIS 3360 with a grade of "C" (2.0) or better; CR: COP 4600 or CGS 3763 or EEL 4882. Understanding of secure operating systems requirements, design principles and theories, protection methods, access control, authentication, vulnerability, analysis and case studies. *Spring*.
CS Elective Course IT Elective Course	**CIS 4364 ENGR-CS 3(3,3,0) Cyber Defense Analysis:** PR: CIS 3360 with a grade of "C" (2.0) or better. Behavioral analytics applied to networks/devices to combat cybersecurity threats. Capture, monitor, respond to network traffic findings. Software/application security, automation, threat hunting, regulatory compliance. *Fall*.
** CS Elective Course (This is an IT course; only one IT course is allowed as CS elective) IT Required Course	**CIS 4524 ENGR-CS 3(3,0) Managing IT Integration:** PR: CGS 2545C and COP 3223C and Information Technology major, with a grade of "C" (2.0) or better or COP 3503C and Computer Science major, with a grade of "C" (2.0) or better. Requirements, acquisition and sourcing. Integration. Project management. Testing and QA. Organizational context. Architecture. *Fall, Spring*.
CS Elective Course IT Elective Course	**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. Threat modeling and risk analysis, development of secure software, software assurance techniques, analyzing and auditing software. *Fall*.

Program	Course
CS Elective Course IT Elective Course	**CIS 4940C ECS-EECS 3(1,3) Topics in Cybersecurity:** PR: CIS 3360 or C.I. A directed and supervised investigation of selected problems, issues, and trends in cybersecurity, with emphasis on laboratory simulations of system penetration methods and network defense strategies. *Fall, Spring.*
IT Elective Course	**CIS 4941 ECS-CS 3(3,0) Approved IT Internship Experience:** PR: A cumulative UCF GPA of 3.0 or higher and have successfully completed: CGS2545, CIS3003, COP3330, COP3502C, and MAD2104, and have an approved IT-related internship. *Fall, Spring, Summer*
IT Required Course	**CIS 4991 ENGR-CS 0(0,0) IT Career and Academic Advising II:** PR: CIS 3921 and IT major. Mandatory meeting with students and their faculty advisor for career/academic advising. *Fall, Spring.*
IT Required Course	**CNT 3004 ECS-CS 3(3,0) Computer Network Concepts:** PR: PHY 2053C with a grade of "C" (2.0) or better and, CR: CIS 3990. Network media, protocol, current and evolving standards for local, metropolitan, wide area and wireless networks. *Fall, Spring.*
CS Elective Course IT Elective Course	**CNT 4403 ECS-CS 3(3,0) Network Security and Privacy:** PR: (CNT 3004 or EEL 4781 or CNT 4704) and (CIS 3360 or CIS 3362) all with a grade of ""C"" (2.0) or better or C.I. Fundamentals of network security, protocols, secure applications, network intrusion detection, security policy, firewalls, and privacy issues. *Spring.*
** CS Elective Course (This is an IT course; only one IT course is allowed as CS elective) IT Required Course	**CNT 4603 ECS-CS 3(3,0) System Administration and Maintenance:** PR: CGS 3763 or COP 3503C and CS major, with a grade of ""C"" (2.0) or better. An examination of operating systems and applications installation, configuration, and maintenance, including client-server services, content management and deployment, server administration and management, and user/group management. *Fall, Spring.*
** CS Elective Course (This is an IT course; only one IT course is allowed as CS elective) IT Required Course	**CNT 4703C ECS-CS 3(1,2) Design & Implementation of Comp Comm Network:** PR: (CNT 3004, COP 3502C and either MAD 2104 or COT 3100C) or (COP 3503C and Computer Science major) all with a grade of ""C"" (2.0) or better. 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
CS Elective Course IT Elective Course	**CNT 4704 ECS-CS 3(3,0) Analysis of Computer Communication Networks:** PR: (COT 3100C or MAD 2104) and STA 2023 each with grades of ""C"" (2.0) or better. Network design using layering. Introduces cabling, topology, architecture, hardware and software. Includes performance and control issues such as congestion control, error control, contention resolution. *Fall.*
** CS Elective Course (This is an IT course; only one IT course is allowed as CS elective) IT Required Course	**CNT 4714 ECS-CS 3(3,0) Enterprise Computing:** PR: (CGS 3269, MAD 2104, COP 3330 and COP 3502C) or (COP 3503C and Computer Science or Computer Engineering major) all with a grade of ""C"" (2.0) or better. 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.*

Program	Course
CS Elective Course IT Elective Course	**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.*
CS Elective Course IT Elective Course	**CNT 5805 ECS-EECS 3(3,0) Network Science:** PR: Undergraduate degree in CS, EE, or CpE. The emerging science of complex networks and their applications. Focus will be on algorithms, mathematical theories, and computational methods that analyze complex networks and predict their behavior. *Fall.*
CS Required Course IT Required Course	**COP 3223C ENGR-CS 3(3,1) Introduction to Programming with C:** PR: COP 2500C with a "C" (2.0) or better, or Appropriate score on the UCF CS Placement Exam, or Consent of Instructor. CR: PR/CR: Programming in C including arrays, pointer manipulation and use of standard C math and IO libraries. *Fall, Spring.*
CS Required Course IT Required Course	**COP 3330 ECS-ECE 3(3,0) Object Oriented Programming:** PR: COP 2500C with a grade of "C" (2.0) or better 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.*
CS Required Course IT Elective Course	**COP 3402 ECS-ECE 3(3,0) Systems Software:** PR: CDA 3103C and COP 3502C each with a grade of "C" (2.0) or better. Design and development of assemblers, linkers, loaders, and compilers. Study memory hierarchy, program performance, and system level I/O. *Fall, Spring.*
CS Required Course IT Required Course	**COP 3502C ECS-CS 3(3,1) Computer Science I:** PR: (COP 3223C or EGN 3211) and MAC 1105C all with a grade of “C” (2.0) or better. Problem solving techniques, order analysis and notation, abstract data types, and recursion. *Fall, Spring.*
CS Required Course IT Elective Course	**COP 3503C ECS-CS 3(3,1) Computer Science II:** PR: COP 3502C and COP 3330 and MAD 2104 (for CS minor) or COT 3100C (for CS major) all with a grade of "C" (2.0) or better. 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.*
CS Elective Course (CS Required Course for Ct. Yr. 2016 and prior) IT Elective Course	**COP 4020 ECS-CS 3(3,0) Programming Languages I:** PR: COP 3503C with a grade of ""C"" or better 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.* This is a CS Elective for catalog year 2017-2018 or later.
IT Elective Course	**COP 4283 ENGR-CS 3(3,0) Data Science Programming:** PR: COP 3223C Programming for data processing and analytics, including languages and platforms used in science such as SAS, R, Julia, and Python. Intensive coding projects. *Fall.*
CS Required Course IT Elective Course	**COP 4331C ECS-CS 3(3,1) Processes for Object-Oriented Software Development:** PR: COP 3503C with a grade of "C" (2.0) or better and COT 3960 (CS majors). Concepts, principles, processes, and methods for developing large software systems featuring a team project using object-oriented design in UML and implementation in C++. *Fall, Spring.*

Program	Course
CS Elective Course IT Elective Course	**COP 4516C ECS-CS 3(1,3) Problem Solving Techniques and Team Dynamics:** PR: COP 3503C with a grade of "C" (2.0) or better. Design and implement solutions toproblems requiring the applications of the different algorithms. Team project format. *Spring.*
CS Elective Course IT Elective Course	**COP 4520 ECS-CS 3(3,0) Concepts of Parallel and Distributed Processing:** PR: COP 3402 and COP 3503C each with a grade of "C" (2.0) or better and COT 3960. Parallel anddistributed paradigms, architectures and algorithms, and the analytical tools, environmentsand languages needed to support these paradigms. *Spring.*
CS Elective Course (CS Required Course for Ct. Yr. 2016 and prior) IT Elective Course (IT ONLY – or can substitute CGS 3269)	**COP 4600 ECS-CS 3(3,0) Operating Systems:** PR: COP 3503C and COP 3402 (CS majors) each with a grade of "C" (2.0) or better and COT3960 (CS majors). Function and organization of operating systems, process management, virtual memory, I/O management, and file management. *Fall, Spring.* This is a CS Elective for catalog year 2017-2018 or later.
CS Elective Course IT Elective Course (IT ONLY – or can substitute CGS 2545C)	**COP 4710 ECS-CS 3(3,0) Database Systems:** PR: COP 3503C with a grade of "C" (2.0) or better. Storage and access Structures, database models and languages, related database design, and implementation techniques for database management systems. *Fall, Spring.*
IT Required Course	**COP 4910 ECS-CS 3(3,0) Frontiers in Information Technology:** PR: CNT 4603 with a grade of "C" (2.0) or better; CR: CNT 4703C and CIS 4991. Researchinto leading edge information technologies that have a high likelihood of affecting the workplace in the two-to-five-year time frame. *Fall, Spring.*
CS Required Course	**COP 4934 ECS-CS 3(3,0) Senior Design I:** PR: COP 3402 and COP 3503C each with a grade of "C" (2.0) or better and consent ofDepartment of EECS; CR: COP 4331C. Students work in teams to demonstrate their knowledge of computer science and apply it to realistic and meaningful problems. *Fall,Spring.*
CS Required Course	**COP 4935 ECS-CS 3(3,0) Senior Design II:** PR: COP 4934 with a grade of "C" (2.0) or better. Students work in teams to demonstrate their knowledge of computer science and apply it to realistic and meaningful problems. *Fall, Spring.*
CS Elective Course	**COP 4941 ECS-CS 3(3,0) Approved CS Internship Experience:** PR: A cumulative UCF GPA of 3.0 or higher and have successfully completed: COP 3503C and have an approved CS-related internship. *Fall, Spring, Summer*
CS Elective Course IT Elective Course	**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 type and effect systems.Tools to automate program analysis. *Even Spring.*
CS Elective Course IT Elective Course	**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.*

Program	Course
CS Elective Course IT Elective Course	**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 queuingtheory, security, distributed systems, case studies. *Spring.*
CS Elective Course IT Elective Course	**COP 5621 ECS-CS 3(3,0) Compiler Construction:** PR: COP4020 and COT 4210. Techniques in the design and implementation of compilers. Optimization, code generation, error recovery, attributed grammars. A project is required. *Odd Fall.*
CS Elective Course IT Elective Course	**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, multi database systems. *Fall, Spring.*
CS Required Course IT substitute of MAD 2104	**COT 3100C ECS-CS 3(3,1) Introduction to Discrete Structures:** CR: MAC 2311C with a grade of "C" (2.0) or better. Logic, sets, functions, relations, combinatorics, graphics, Boolean algebras, finite-state machines, Turingmachines, insolvability, computational complexity. *Fall, Spring.*
CS Required Exam CS students must pass this exam within one calendar year of COP3502C completion	**COT 3960 ECS-CS 0(1,0) Passed CS Foundation Exam:** PR: COP 3502C with a grade of "C" (2.0) or better. Foundation examination for computerscience majors. Required before taking advanced core courses in Computer Science andupper-division 4000 and 5000 level CS electives. Graded S/U. *Fall, Spring, Summer.*
CS Required Course IT Elective Course	**COT 4210 ECS-CS 3(3,0) Discrete Structures II:** PR: COP 3503C with a grade of "C" (2.0) or better and COT 3960. Computation Theory. A study of the properties of grammars and automata as formal specifications for algorithms andfamilies of languages. *Fall, Spring.*
CS Elective Course IT Elective Course	**COT 4400 ECS-CS 3(3,0) Tools for Algorithm Analysis:** PR: COT 3960 and COP 3503C. Tools from discrete and continuous mathematics foranalyzing complexity of algorithms. Order notation use and manipulation. *Occasional.*
CS Elective Course IT Elective Course	**COT 4500 ECS-CS 3(3,0) Numerical Calculus:** PR: MAC 2312 and COP 3223C each with a grade of "C" (2.0) or better. Numerical methods for finding roots of nonlinear equations, solutions of systems of linear equations, and ordinary differential equations. *Spring.*
CS Elective Course IT Elective Course	**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.*
CS Elective Course IT Elective Course	**COT 5600 ECS-CS 3(3,0) Quantum Computing**: PR: COP 3503C. This course introducesbasic concepts in quantum circuits and quantum algorithms. *Occasional.*

Program	Course
CS Elective Course IT Elective Course	**EEE 4346C ECS-ECE 3(2,3) Hardware Security and Trusted Circuit Design:** PR: EEL 3801C with a grade of "C" (2.0) or better. Design, analysis and synthesis of sequential logiccircuits and systems. Data path and controller design using a hardware descriptive language. Case studies on hardware security. *Spring.* This is a CS Elective for catalog year 2017-2018 or later.
CS Elective Course IT Elective Course	**EEL 4660 ECS-ECE 3(3,0) Robotic Systems:** PR: EGN 4060C or EEL 4742C or COP 3503C. Team based development of a roboticsystem incorporating concepts such as sensing, computer vision, machine learning, localization, mapping, manipulation and locomotion. *Spring.*
CS Elective Course (CS Required Course for Ct. Yr. 2016 and prior) IT Elective Course (IT ONLY – or can substitute CGS 3269)	**EEL 4768 ECS-ECE 3(3,0) Computer Architecture:** PR: EEL 3801C or CDA3103C with a grade of "C" (2.0) or better. Computer systems performance and evaluation, processor data path and control, microprogrammed architectures,instruction and arithmetic pipelines, cache and virtual memory, and RISC vs. CISC. *Fall, Spring.* This is a CS Elective for catalog year 2017-2018 or later.
CS Elective Course	**EEL 4781 ECS-ECE 3(3,0) Computer Communication Networks:** PR: EEL 3801C with a grade of "C" (2.0) or better and STA 3032. Network models. Mediaaccess protocols. Data link control. Routing and flow control. Internetworking. Current architectures and protocols: OSI, ethernet, token, ring, FDDI, HSLC,X.25, etc. *Fall, Spring.* This is a CS Elective for catalog year 2017-2018 or later.
CS Elective Course	**EEL 5780 ECS-ECE 3(3,0) Wireless Networks:** PR: EEL 4781 or C.I. The wireless networking topics include: cellular networks, multiple access protocols, channel assignment and resource allocation, mobility and location management, handoffs, routing, authentication, call admission control and QoS provisioning,network layer issues, wireless data networking (WAP, GSM, GPRS, CDMA, WCDMA.). *Even Spring*. This is a CS Elective for catalog year 2017-2018 or later.
CS Elective Course	**EEL 5820 ECS-ECE 3(3,0) Image Processing:** PR: MAP 2302, EEL 4750 or C.I. Two-dimensional signal processing techniques; pictorial image representation; spatial filtering; image enhancement and encoding; segmentation andfeature extraction; introduction to image understanding techniques. *Odd Spring*. This is a CS Elective for catalog year 2017-2018 or later.
CS Elective Course	**EGN 4060C ECS-ECE 3(2,3) Introduction to Robotics:** PR: COP 3223C or EGN 3211; and EEL 3657or EEL 4742C or COP 3503C or EGN 3321 or EML 3217. Theory and application of robotics topics including: architecture, pathplanning, sensing and manipulation. *Spring*.
CS Elective Course IT Elective Course (Can only take either EGN 4630 or EGN 5640 – not both)	**EGN 4630 ENGR-COMP SCI 3(3,0) Entrepreneurship for Defense:** PR: Complete the following: ENC1101 - Composition I (3) Teaches entrepreneurship via Lean Startup. Students work in teams to rapidly design products and services that solve real problems for the Defenseand Intelligence Community. *Spring*.

CS Elective Course IT Elective Course	**EGN 4641 ENGR-COMP 3(3,0) Engineering Entrepreneurship** PR: Consent of Instructor. Apply at http://www.cecs.ucf.edu/egn4641/. Students work in teams and use the Lean Startup Methodology to learn how to launch a new product or service into the global marketplace. Students gain direct exposure to both the theory and practice of entrepreneurship from serial entrepreneurs, in particular focusing on Customer Discoveryand establishing Product Market Fit, with the goal of defining sustainable new technologyventures. *Fall.*
CS Elective Course (Can only take either EGN 4630 or EGN 5640 – not both)	**EGN 5640 ENGR-COMP SCI 3(3,0) Entrepreneurship for Defense:** Teaches entrepreneurship via Lean Startup. Students work in teams to rapidly design products and services that solve real problems for the Defense and Intelligence Community. *Spring*.
CS Elective Course	**MAP 4384 COS-MATH 3(3,0) Numerical Methods for Computational Sciences:** PR: MAP 2302, and COP 3223, and MAS 3105 or MAS 3106. Theory of modern methods of numerical computation and numerical analysis in linear algebra and differential equations; non-linear optimization, finite element methods, adaptive quadrature. *Occasional*.
CS Elective Course	**PHY 3650 COS-PHYSICS 3(3,0) Quantum Information Processing:** PR: (PHY2049C or PHY2049/L) and (MAC2313 or MAS3105); or CI Overview of fundamental and practical aspects of quantum information processing, with emphasis on quantum computation and quantum communications. *Spring*