

COMPUTER SCIENCE

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Chairperson: Loren Schwiebert

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h (<http://www.cs.wayne.edu>)<http://engineering.wayne.edu/cs> (<http://engineering.wayne.edu/cs>)

Mission Statement

The mission of the Department of Computer Science at Wayne State University is to provide excellence in teaching, research, public service, and leadership in the computer science profession and the community. The Department provides a high-quality, innovative, baccalaureate and graduate education that emphasizes the fundamentals of computer science as well as the most recent technological innovations, preparing students for employment and advanced studies. Students are encouraged to become involved in research programs to enhance their education and their employment opportunities. Through the use of our state-of-the-art laboratory facilities, students can conduct basic and applied research of high quality, influence, visibility, and potential community impact. The Department continues to develop cooperative research relationships within and outside the computer science discipline, as well as with industry, government and alumni, and local community organizations. This worldwide interaction with professional organizations provides our students with the highest standards, goals, and professional practices.

Bachelor's Degree Programs

Bachelor of Arts degree programs in computer science (<http://bulletins.wayne.edu/undergraduate/college-liberal-arts-sciences/computer-science>) and information systems technology (<http://bulletins.wayne.edu/undergraduate/college-liberal-arts-sciences/information-systems-technology>) are offered by the College of Liberal Arts and Science. The following academic regulations pertain to the Bachelor of Science degrees offered by this department.

Research and Instructional Laboratories

The Department of Computer Science operates a number of teaching and research laboratories. Research laboratories are organized around individual fields of research interest. The teaching laboratories are supported by the Department and are available to all students for class work and research. The Department also maintains a Learning and Resource Center.

ARSLANTURK, SUZAN: Ph.D., Oakland University; M.S., Oakland University; B.S., Baskent University; Assistant Professor

BOSU, AMIANGSHU S.: Ph.D., M.S., University of Alabama; B.S., Bangladesh University of Engineering and Technology; Assistant Professor

BROCANELLI, MARCO: Ph.D., Ohio State University; M.E., B.E., University of Rome Tor Vergata; Assistant Professor

BROCKMEYER, MONICA: Ph.D., M.S., B.S., University of Michigan; Associate Professor

CHEN, XUE-WEN: Ph.D., Carnegie Mellon University; M.S., B.S., Sichuan University; Professor

DONG, MING: Ph.D., University of Cincinnati; B.S., Shanghai Jiao Tong University; Associate Professor

DRAGHICI, SORIN: Ph.D., St. Andrews University; M.S., B.S., Politecnica University; Professor

FISHER, NATHAN: Ph.D., University of North Carolina; M.S., Columbia University; B.S., University of Minnesota; Associate Professor

FOTOUHI, FARSHAD: Ph.D., Michigan State University; M.S., B.S., Western Michigan University; Professor

GOEL, NARENDRA S.: Ph.D., University of Maryland; M.S., Poona University; M.S., Delhi University; B.S., Agra University; Professor

GROSU, DANIEL: Ph.D., M.S., University of Texas at San Antonio; B.S., Technical University of Iasi; Associate Professor

HUA, JING: Ph.D., M.S., State University of New York at Stony Brook; M.S., Institute of Automation, Chinese Academy of Sciences; B.S., Huazhong University of Science and Technology; Professor

JAYYOUSI, THAER: Ph.D., M.S., B.S., Wayne State University; Senior Lecturer

KOTOV, ALEXANDER: Ph.D., M.S., University of Illinois at Urbana-Champaign; B.S., Tver State Technical University; Assistant Professor

LU, SHIYONG: Ph.D., State University of New York at Stony Brook; M.E., Institute of Computing Technology, Chinese Academy of Sciences; B.E., University of Science and Technology of China; Associate Professor

MOUSAVI MOJAB, SEYED ZIAE: M.S., Wayne State University; B.S., University of Michigan; B.A., University of Tehran; Lecturer

OUELLETTE, DANIEL J.: M.S., Eastern Michigan University; B.S., University of Michigan; Lecturer

RAJLICH, VACLAV: Ph.D., Case Western Reserve University; M.S., Czech Technical University; Professor

REYNOLDS, ROBERT G.: Ph.D., M.S., M.A., B.S., University of Michigan; Professor

SAIFULLAH, ABUSAYEED: Ph.D., Washington University in St Louis; M.S., University of Windsor; B.S., Bangladesh University of Engineering and Technology; Assistant Professor

SALAYMEH, AREEJ: M.S., Jordan University of Science and Technology; B.S., Yarmouk University; Lecturer

SCHWIEBERT, LOREN J.: Ph.D., M.S., Ohio State University; B.S., Heidelberg University; Associate Professor and Chair

SHI, WEISONG: Ph.D., Chinese Academy of Sciences; B.E., Xidian University; Professor

XU, LIHAO: Ph.D., California Institute of Technology; M.Sc., B.Sc., Shanghai Jiao Tong University; Associate Professor

ZHANG, FENGWEI: Ph.D., George Mason University; M.S., Columbia University; B.S., Southern Polytechnic State University; B.S., North China University of Technology; Assistant Professor

ZHONG, ZICHUN: Ph.D., M.S., University of Texas at Dallas; M.S., B.S., The University of Electronic Science and Technology of China; Assistant Professor

ZHU, DONGXIAO: Ph.D., M.A., University of Michigan; M.A., Eastern Michigan University; M.S., Peking University; B.S., Shandong University; Associate Professor

- Computer Science (B.S.) (<http://bulletins.wayne.edu/undergraduate/college-engineering/computer-science/computer-science-bs>)

- Computer Science Minor (<http://bulletins.wayne.edu/undergraduate/college-engineering/computer-science/computer-science-minor>)

CSC 0900 Office Applications Cr. 0

Self-paced course provides instruction in the Microsoft Office Application software at both introductory and advanced levels; software covered includes Word, Excel, and Power Point. Offered Every Term.

Course Material Fees: \$25

CSC 0995 Co-op or Internship in Computer Science Cr. 0

Review of computer science practical experiences resulting from participation in coop/internship program. Offered Every Term.

CSC 1000 Introduction to Computer Science Cr. 3

Provides an overview of current computing technology, organization, and use. Topics surveyed include data representation and storage, hardware and software organization, communications technologies, ethical and security issues. Provides hands-on training in common application software, such as word processing, spreadsheets, presentation, as well as in electronic telecommunications, such as e-mail, Internet and database searches. The University database and Internet pages are emphasized. Offered Every Term.

Course Material Fees: \$35

CSC 1002 Personal Digital Security Cr. 3

Students learn how to reduce exposure to risks and how to identify, assess and repair infected devices. Offered Every Term.

CSC 1050 Introduction to C and Unix Cr. 2

Introduction to Unix, Unix editor, and C Programming Language. Unix development tools and fundamentals of C language discussed. No credit for computer science students after CSC 1100. Offered Every Term.

Prerequisite: MAT 1800 with a minimum grade of C

Course Material Fees: \$35

CSC 1100 Problem Solving and Programming Cr. 3

Problem solving with algorithms, and their realization as computer programs using a structured, general purpose programming language; data types, operators, expressions, assignment, input and output, selection and repetition control structures; modularity and procedural abstraction using functions with parameters; structured data types, arrays, pointers and strings. Offered Every Term.

Corequisite: CSC 1101

CSC 1101 Problem Solving and Programming Laboratory Cr. 1

Mandatory two-hour closed laboratory; discussion of lecture materials and completion of hands-on exercises. Implementing programs using a general purpose programming language; software resulting from this can be used in more advanced computer science courses. Offered Every Term.

Corequisite: CSC 1100

Course Material Fees: \$35

CSC 1500 Fundamental Structures in Computer Science Cr. 3

Introduction to fundamental control and data structures in computer science such as algorithms and complexity; recursive algorithms; program correctness using the predicate calculus; reasoning about algorithms using mathematical induction; divide and conquer algorithms; recurrence relations; set properties and their computation; and computing with relations. Graph properties and their computation, and tree properties and their computation, will be covered if time permits. Offered Every Term.

Prerequisites: CSC 1100 with a minimum grade of C and CSC 1101 with a minimum grade of C and MAT 2010 with a minimum grade of C-

Corequisite: CSC 1501

CSC 1501 Fundamental Structures in Computer Science Lab Cr. 1

Discussion and supervised hands-on exercises to complement CSC 1500. Offered Every Term.

Corequisite: CSC 1500

Course Material Fees: \$35

CSC 2000 Introduction to C++ Programming Language Cr. 3

Elements of C++; arrays, pointers and references; operators; classes and objects. No credit for Computer Science majors. Offered Every Term.

Prerequisites: MAT 1800 with a minimum grade of C- or MAT Permit to Reg ACT/SAT with a test score minimum of 4 or Math Permit to Reg - L1-L4 with a test score minimum of 4 or MAT 2010 with a minimum grade of C-

Course Material Fees: \$35

CSC 2110 Computer Science I Cr. 3

Rigorous introduction to fundamental object-oriented concepts and techniques of computer programming using an object-oriented language. Introduction to data abstraction; design of abstract data types. Introduction to recursion; programming with generic data types; inheritance; polymorphism; and exception handlers. Concepts applied to console programs and event-driven programming using a simple graphics API. Offered Every Term.

Prerequisites: CSC 1100 with a minimum grade of C and CSC 1101 with a minimum grade of C and MAT 2010 with a minimum grade of C-

Corequisite: CSC 2111

CSC 2111 Computer Science I Lab Cr. 1

Mandatory two-hour supervised lab; hands-on exercises to complement CSC 2110. Object-oriented techniques in a general-purpose object-oriented programming language. Resulting software may be used in more advanced computer science courses. Offered Every Term.

Corequisite: CSC 2110

Course Material Fees: \$35

CSC 2200 Computer Science II Cr. 3

Design and implementation of fundamental abstract data types of computer science (such as stacks, queues, trees, lists, hashing, and graphs), using an object-oriented language. Programming requirements include the implementation of abstract data types using arrays and dynamic links; recursion; sorting and searching; hashing; and string processing. Introduction to algorithm analysis. Offered Every Term.

Prerequisites: CSC 1500 with a minimum grade of C and CSC 1501 with a minimum grade of C and CSC 2110 with a minimum grade of C and CSC 2111 with a minimum grade of C and MAT 2010 with a minimum grade of C-

Corequisite: CSC 2201

CSC 2201 Computer Science II: Lab Cr. 1

Hands-on lab which complements lecture material in CSC 2200. Lab attendance is mandatory. Implementing data structures and algorithms using object-oriented techniques; techniques of analysis of algorithms; resulting implementations are working pieces of software that can be used in more advanced computer science courses. Offered Every Term.

Corequisite: CSC 2200

Course Material Fees: \$35

CSC 3010 Ethics in Computer Science Cr. 3

Students will study the ethical and legal issues that arise with the usage and development of computing technology. Students will learn the responsibilities of the computer professionals and how to make appropriate decisions when faced with legal and ethical issues in computing. Offered Every Term.

Prerequisites: CSC 2110 with a minimum grade of C and CSC 2111 with a minimum grade of C

CSC 3020 Java Programming Cr. 3

Introduction to the fundamentals of programming using Java. Topics include: object-oriented programming, classes, constructors, flow control statements, data types, methods, inheritance, data hiding, abstraction, exceptions, file I/O, Java GUI, and Java packages. Offered Fall, Winter.

Prerequisites: MAT 1800 with a minimum grade of C- or MAT 2010 with a minimum grade of C- or MAT 2020 with a minimum grade of C- and CSC 1100 with a minimum grade of C and CSC 1101 with a minimum grade of C

CSC 3100 Computer Architecture and Organization Cr. 3

Organization and architecture of computer systems. Topics include: digital logic and digital systems; machine-level representation of data and programs; assembly level machine organization and programming; register-level description of computer execution and the functional organization of a computer; role and function of programming languages, libraries and operating systems; performance evaluation; systems programming. Offered Every Term.

Prerequisites: CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C and MAT 2010 with a minimum grade of C-

Corequisite: CSC 3101

CSC 3101 Computer Architecture and Organization: Lab Cr. 1

Two-hour closed lab; students explore and experiment with assembly language programming, data representation, and simple circuit design. Lab attendance is mandatory. Offered Every Term.

Corequisite: CSC 3100

Course Material Fees: \$35

CSC 3110 Algorithm Design and Analysis Cr. 3

Formal techniques to support design and analysis of algorithms: underlying mathematical theory and practical considerations of efficiency. Topics include asymptotic complexity bounds, techniques of analysis, algorithmic strategies, advanced data and file structures, and introduction to automata theory and its application to language translation. Offered Fall, Winter.

Prerequisites: BE 2100 with a minimum grade of C- and CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C and MAT 2250 with a minimum grade of C- and MAT 2020 with a minimum grade of C-

CSC 3200 Programming Languages Cr. 3

History and overview of programming languages, virtual machines, representation of data types; sequence control; data control, sharing and type checking; run-time storage management; language translation systems; programming language semantics; programming paradigms. Offered Yearly.

Prerequisites: CSC 2200 with a minimum grade of C- and CSC 2201 with a minimum grade of C- and MAT 2010 with a minimum grade of C-

CSC 3400 Human-Computer Interaction Cr. 3

User interface design, usability, evaluation, user-centered design. Offered Intermittently.

Prerequisites: CSC 2110 with a minimum grade of C and CSC 2111 with a minimum grade of C

Course Material Fees: \$10

CSC 3750 Introduction to Web Technology Cr. 3

Understanding the Internet using several access methods; required software and tools. Topics include: e-mail, FTP, Telnet, Gopher, Archie, Newsgroups, WWW, HTML, CGI and PHP scripting and how to create an active web site. Laboratory exercises required. No credit after CSC 5750. Offered Fall, Winter.

Prerequisites: CSC 1100 with a minimum grade of C and CSC 1101 with a minimum grade of C

CSC 4110 Software Engineering Cr. 3

Software life cycle; software requirement analysis; software system design; software implementation and testing; software maintenance; team programming; ethics and programmers. Offered Fall, Winter.

Prerequisites: CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C and MAT 2010 with a minimum grade of C- or MAT 3430 with a minimum grade of C-

Corequisite: CSC 4111

Course Material Fees: \$10

CSC 4111 Software Engineering: Lab Cr. 1

Mandatory two-hour closed lab; lecture materials and hands-on exercises which complement CSC 4110. Offered Fall, Winter.

Corequisite: CSC 4110

Restriction(s): Enrollment is limited to Undergraduate level students.

Course Material Fees: \$35

CSC 4290 Introduction to Computer Networking Cr. 3

Introduction of topics such as network architecture, multiple access control, packet switching, routing and flow control, congestion control and quality-of-service, Internet protocols, and elements of distributed computing. Offered Yearly.

Prerequisites: CSC 2200 with a minimum grade of C- and CSC 2201 with a minimum grade of C- and CSC 3100 with a minimum grade of C- and CSC 3101 with a minimum grade of C-

Restriction(s): Enrollment is limited to Undergraduate level students.

CSC 4420 Computer Operating Systems Cr. 3

Operating system services; file systems; CPU scheduling; memory management; virtual memory; disk scheduling; deadlocks; concurrent processes. Offered for undergraduate major credit only. Offered Fall, Winter.

Prerequisites: CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C and CSC 3100 with a minimum grade of C- and CSC 3101 with a minimum grade of C-

Corequisite: CSC 4421

CSC 4421 Computer Operating Systems: Lab Cr. 1

Mandatory two-hour closed lab; lecture materials and hands-on exercises which complement CSC 4420. System call interface; introduction to operating systems programming; use of simulation to better understand operating systems behavior. Offered Fall, Winter.

Corequisite: CSC 4420

Course Material Fees: \$35

CSC 4500 Introduction to Theoretical Computer Science Cr. 3

Finite automata and regular expressions; context-free grammars; pushdown automata; Turing machines; hierarchy of formal languages and automata; computability and decidability. Offered Fall, Winter.

Prerequisite: (CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C and MAT 2010 with a minimum grade of C-) or (CSC 5050 with a minimum grade of C and MAT 2010 with a minimum grade of C-)

CSC 4710 Introduction to Database Management Systems Cr. 3

Topics include: database concepts, ER modeling, schemas and constraints, SQL and relational algebra, web-based database applications, triggers and views, physical organization and indexing, query processing, query optimization, NoSQL databases. Offered Yearly.

Prerequisites: CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C

CSC 4990 Directed Study Cr. 1-4

Individual study as agreed on by student and supervising faculty. Primarily for material not covered in regular courses. Offered Every Term.

Restriction(s): Enrollment is limited to Undergraduate level students.

Repeatable for 8 Credits

CSC 4992 Special Topics in Computer Science Cr. 1-3

Topics to be announced in the Schedule of Classes. Maximum of six credits may be applied toward satisfying the computer science elective, in any computer science degree program. Offered Yearly.

Prerequisite: CSC 2110 with a minimum grade of C and CSC 2111 with a minimum grade of C

Course Material Fees: \$35

Repeatable for 12 Credits

CSC 4995 Professional Practice in Computer Science Cr. 1

Review of computer science practical experiences resulting from participation in the cooperative work-study program. Offered Every Term.

Restriction(s): Enrollment limited to students with a class of Junior or Senior.

Repeatable for 4 Credits

CSC 4996 Senior Project and Computer Ethics Cr. 3

Satisfies General Education Requirement: Writing Intensive Competency
Development of skills for planning, managing, implementing, and documenting complex software projects; legal, social and ethical issues in software development and computer use. Project management techniques; professional conduct, social responsibility, liability, ownership of information, privacy, security and crime. Offered Fall, Winter.

Prerequisites: CSC 4110 with a minimum grade of C- and CSC 4111 with a minimum grade of C- and CSC 4710 with a minimum grade of C-

Corequisite: CSC 4997

Restriction(s): Enrollment limited to students with a class of Senior; enrollment is limited to students with a major in Computer Science, Computer Science Honors or Information Systems Technology.

CSC 4997 Senior Project Lab Cr. 1

Development of project management skills while managing, implementing and documenting a real-world project from initial idea to final implementation. Theory, software engineering techniques, group activities, and computer tools such as Microsoft Project. Mandatory lab. Offered Fall, Winter.

Prerequisites: CSC 4110 with a minimum grade of C- and CSC 4111 with a minimum grade of C- and CSC 4710 with a minimum grade of C-

Corequisite: CSC 4996

Restriction(s): Enrollment limited to students with a class of Senior; enrollment is limited to students with a major in Computer Science, Computer Science Honors or Information Systems Technology.

Course Material Fees: \$35

CSC 4999 Honors Thesis Cr. 3-6

Independent study under supervision. Offered Every Term.

Restriction(s): Enrollment limited to students with a class of Senior.

CSC 5050 Algorithms and Data Structures Cr. 4

Introduction to problem solving methods and algorithm development; data abstraction for structures such as stacks, queues, linked lists, trees, and graphs; searching and sorting algorithms and their analysis. Not for CSC major credit. Offered for graduate credit only. Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students.

Equivalent: ECE 4050

CSC 5250 Network, Distributed, and Concurrent Programming Cr. 3

Fundamental concepts and skills of developing networked, distributed, and concurrent applications. Topics include: inter-process communication, TCP/IP sockets programming, remote method invocation, multithreading, concurrency and synchronization. Offered Yearly.

Prerequisites: CSC 4420 with a minimum grade of C- and CSC 4421 with a minimum grade of C-

CSC 5270 Computer Systems Security Cr. 3

Fundamental technologies for enabling an e-society which is more predictable, more accountable, and less vulnerable to attacks. Covers three components: security requirements and protocols, cryptography algorithms, and case studies. Offered Fall.

Prerequisites: CSC 5250

CSC 5280 Introduction to Cyber-Physical Systems Cr. 3

Topics include: modeling, design, analysis, and implementation of cyber-physical systems; dynamic behavior modeling, state machine composition, and concurrent computation; sensors and actuators; embedded systems and networks; feedback control systems; temporal logic and model checking. Offered Fall, Winter.

Prerequisites: CSC 3100 with a minimum grade of C- and CSC 3110 with a minimum grade of C-

Restriction(s): Enrollment limited to students in the College of Engineering.

Equivalent: ECE 5280

CSC 5290 Cyber Security Practice Cr. 3

Provides hands-on experience in playing with security software and network systems in a live laboratory environment, with the purpose of understating real-world threats. Focus will be on attacks (e.g., buffer overflow, heap spray, kernel rootkits, and denial of service), hacking fundamentals (e.g., scanning and reconnaissance), and defenses (e.g., intrusion detection systems and firewalls). Offered Winter.

Prerequisites: CSC 4420 with a minimum grade of C-

CSC 5430 Game Programming and Design I Cr. 3

Fundamentals of game programming and game design using C++, DirectX, Windows, and C#. Offered Fall.

Prerequisites: CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C or CSC 5250 with a minimum grade of C-

Corequisite: CSC 5431

CSC 5431 Game Programming and Design I: Lab Cr. 1

Laboratory for CSC 5430. Focus on modding, or making changes to existing programs to achieve specific results. Offered Fall.

Corequisite: CSC 5430

Course Material Fees: \$25

CSC 5710 Design of Intelligent Information Retrieval Systems Cr. 3

Indexing retrieval models (vector space, probabilistic and language models); document classification models (Naive Bayes and SVM); topic models (PLSA and LDA) and learning-to-rank methods; course includes practical assignments and a team-based final project. Offered Yearly.

Prerequisites: CSC 5800 with a minimum grade of C-

CSC 5750 Principles of Web Technology Cr. 3

History and development of the world-wide web. Techniques for authoring static and dynamic content for the world-wide web. Web security techniques. Electronic commerce on the web. Lab exercises required. Offered Fall, Winter.

Prerequisites: CSC 3750 with a minimum grade of C- and MAT 2010 with a minimum grade of C-

CSC 5800 Intelligent Systems: Algorithms and Tools Cr. 3

Introduction to basic algorithms and software tools for intelligent data representation and analysis, including: data pre-processing, data exploration and visualization, model evaluation, predictive modeling, classification methods, association analysis, clustering, anomaly detection, representing extracted patterns as expertise, tools for data mining and intelligent systems such as WEKA, CLIPS, and MATLAB. Offered Intermittently.

Prerequisites: CSC 2200 with a minimum grade of C, CSC 2201 with a minimum grade of C, and MAT 2010 with a minimum grade of C- or CSC 5050 with a minimum grade of C- and MAT 2010 with a minimum grade of C-

CSC 5825 Introduction to Machine Learning and Applications Cr. 3

Through algorithmic investigation, brainstorming, and case analysis, students develop the skills and strategies that are necessary for effective learning from data, including Big Data emerging from science and engineering. Offered Winter.

Prerequisites: CSC 3110 with a minimum grade of C-

CSC 5830 Computational Modeling of Complex Systems Cr. 3

Introduction to computer methods useful for modeling complex systems which are refractory to traditional methods of analysis. Emphasis on problem formulation and concrete examples drawn from computer science, engineering, chemistry, and biology. Offered Yearly.

Prerequisites: CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C or CSC 5050 with a minimum grade of C-

CSC 5860 Introduction to Pattern Recognition and Document Analysis Cr. 3

Model of a pattern recognition system; representation techniques of classifiers; parametric and nonparametric classification methods; clustering; feature selection and extraction document processing, analysis, and classification. Offered Yearly.

CSC 5870 Computer Graphics I Cr. 3

Graphics devices, graphics primitives, 2-D transformations, windowing and clipping, modeling 3-D objects, 3-D viewing transformations, hidden surface removal, shading and color. Offered Yearly.

Prerequisites: CSC 2200 with a minimum grade of C, CSC 2201 with a minimum grade of C, and MAT 2250 with a minimum grade of C- or CSC 5050 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

CSC 5991 Special Topics in Computer Science Cr. 1-4

Topics to be announced in the Schedule of Classes. Offered Intermittently.

Prerequisites: CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C

Repeatable for 9 Credits

CSC 6110 Software Engineering Cr. 3

Software process models; advanced software system design; software project management; software analysis; testing and performance analysis; software maintenance; reverse engineering; software reuse; software metrics; object-oriented development. Offered Yearly.

Prerequisites: CSC 2200 with a minimum grade of C, CSC 2201 with a minimum grade of C, and MAT 2010 with a minimum grade of C- or CSC 5050 with a minimum grade of C- and MAT 2010 with a minimum grade of C-

CSC 6220 Parallel Computing I: Programming Cr. 4

Parallel computing concepts, examples of parallel computers, parallelism in algorithms / data / programs, experiences with state of the art parallel computers. Offered Yearly.

Prerequisites: 2 of CSC 2200 with a minimum grade of C, CSC 2201 with a minimum grade of C and 3 of CSC 3100 with a minimum grade of C-, CSC 3101 with a minimum grade of C-, CSC 5050 with a minimum grade of C-

CSC 6280 Real-Time and Embedded Operating Systems Cr. 3

Operating system design for real-time and embedded systems. Focus on scheduling, synchronization, communication, and process and memory management for time-critical and resource-constrained applications. Offered Every Other Year.

Prerequisites: CSC 4420 with a minimum grade of C- and CSC 4421 with a minimum grade of C-

CSC 6290 Data Communication and Computer Networks Cr. 3

Data communication fundamentals and principles governing computer communication networks. Components of networks, how they are connected; basics of design and implementation of network protocols. Offered Yearly.

Prerequisites: CSC 5250

CSC 6430 Game Programming and Design II Cr. 3

Game design methods, team development, languages for game design, debugging and testing, game platforms, memory management and I/O, game physics, character animation, AI agents, AI path programming, networking, online and multiplayer gaming. Offered Yearly.

Prerequisites: CSC 5430 with a minimum grade of C- and CSC 5431 with a minimum grade of C-

Corequisite: CSC 6431

CSC 6431 Game Programming and Design II: Lab Cr. 1

Architecture and tools for modern game platforms. Game development environment; basic aspects of game engine design, graphics engine design, use of shaders. Offered Yearly.

Course Material Fees: \$25

CSC 6500 Theory of Languages and Automata Cr. 3

Recursive and recursively enumerable languages; decidability and computability; Rice's theorem; time complexity; space complexity. Offered Fall, Winter.

Prerequisites: CSC 4500 with a minimum grade of C-

CSC 6580 Design and Analysis of Algorithms Cr. 3

Best case, worst case, and expected case complexity analysis; asymptotic approximations; solutions of recurrence equations; probabilistic techniques; divide-and-conquer; the greedy approach; dynamic programming; branch and bound; NP-completeness; parallel algorithms. Offered Fall, Winter.

Prerequisites: CSC 3110 with a minimum grade of C-

CSC 6620 Matrix Computation I Cr. 4

Background matrix algebra; linear system sensitivity; basic transformations; Gaussian elimination; symmetric systems; positive definite systems; Householder method for least squares problems; unsymmetric eigenvalue problems; the QR algorithm. Offered Yearly.

Prerequisites: 3 of CSC 2200 with a minimum grade of C, CSC 2201 with a minimum grade of C, MAT 2250 with a minimum grade of C- and 1 of ECE 3040 with a minimum grade of C-, BE 2550 with a minimum grade of C-

Equivalent: ECE 5020

CSC 6710 Database Management Systems I Cr. 3

Data models, normal forms, relational systems and SQL, query optimization, object-oriented systems, object-relational systems, student Oracle project. Offered Yearly.

Prerequisites: CSC 4710 with a minimum grade of C-

CSC 6720 Data Science Applications Development Cr. 3

Background of SQL and NoSQL databases is necessary. This course focuses on the system development life cycle of a comprehensive data science application. Students will first choose a particular domain and problem to address one of the big data challenges: volume, velocity, or variety. Students will then choose a scalable distributed computing environment to design analytical models to solve business problems. Students will finally develop their data science application using agile methodologies to plan, analyze, design, implement, and operationalize their application. Offered Yearly.

Restriction(s): Enrollment is limited to Graduate level students.

CSC 6800 Artificial Intelligence I Cr. 3

Basic concepts; topics include: recursive problem solving, knowledge representation using semantic networks and frames, state space search methods, planning and problem solving, game playing and adversarial search methods, rules and production systems (RETE networks), constraint satisfaction techniques and applications, optimization algorithms including genetic algorithms, logic programming. Implementation in Lisp and Prolog. Offered Yearly.

Prerequisites: CSC 3110 with a minimum grade of C-

CSC 6860 Digital Image Processing and Analysis Cr. 3

Review of image formation and acquisition; image transformation; image enhancement and restoration; image compression; morphological image processing; edge detection and segmentation; architecture for image processing. Offered Intermittently.

Prerequisites: CSC 3110 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate or Undergraduate level students.

CSC 6870 Computer Graphics II Cr. 3

Representing curves and surfaces; solid modeling; fractal geometry; camera models; illumination models; ray tracing; radiosity methods; transparency; texture; graphics packages. Offered Yearly.

Prerequisites: CSC 5870 with a minimum grade of C-

Course Material Fees: \$20

CSC 6991 Topics in Computer Science Cr. 1-4

Current topics to be announced in the Schedule of Classes. Offered Intermittently.

Prerequisites: CSC 2200 with a minimum grade of C and CSC 2201 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate or Undergraduate level students.

Repeatable for 9 Credits

CSC 6995 Internship in Computer Science Cr. 1-3

Experience in industry using tools from the computer science curriculum. Students provide a written report based on the internship experience. Offered Every Term.

Repeatable for 4 Credits