Course Descriptions

CS 01501: Essentials of Computer Science I 3 s.h.
Prerequisite(s): None
In this course, students will be exposed to the main principles of essential computer science fundamentals and will develop a deeper understanding of advanced topics including systems programming of complex, low level software interacting withthe hardware platform and operating system along with performance constraints. Students will also be proficient with basic scripting and programming in creating simple automated scripts/programs and implementing algorithms utilizing security practices such as bounds checking and input validation.

CS 01502: Essentials of Computer Science II 3 s.h.
Prerequisite: CS 01501
This course covers advanced facets of numerical, object and string data types as well as different types and categories of data structures including lists (array lists, linked list, doubly linked list, other list types, hash tables), arrays, heaps, queue, stacks, buffers, trees and tables in a relational database. Students will be expected to list the most common structures and data formats for storing data in a computer system, discuss the advantages and disadvantages of different data structures/formats, utilize and implement common data structures. Other topics to be discussed include the SQL query language, efficiency calculations for searching and sorting algorithms, and Linux scripting.

CS 01541: Bioinformatics - Advanced Computational Aspects 3 s.h.
Prerequisite(s): graduate student status
This course introduces the advanced student to the computer hardware, software, algorithms and statistical packages that are used in computational aspects of bioinformatics. Hardware topics include multiprocessor clusters, high performance computing, and parallelism. Software topics include message passing and shared memory styles of parallel/concurrent programming languages, databases, available software packages, and visualization techniques for large data sets. Algorithmsand statistical packages include those for the study of molecular biology, evolution, structural biology, and biological networks. Students will design and carry out an independent research project using and developing appropriate bioinformatics algorithms, software and/or hardware. Undergraduate preparation in Calculus, Statistics (preferably Biostatistics), and Introduction to Computer Programming is strongly suggested.

CS 01561: Advanced Computer Environments 3 s.h.
This is an advanced applications course in which the student will learn the effective use of various computer applications for organizing and managing their professional duties, including functioning in computer-supported collaborative work groups. Some specific skills that will be covered include the use of desktop publishing to prepare business plans, advertising copy, etc., the creation and maintenance of World Wide Web pages, the use of presentation packages, the integration of graphics into traditional or multimedia documents, and the use of Internet and commercial data bases (including analysis of data using spreadsheet tools). Students will report on emerging trends in hardware and software and will review issues relating to data security and ethics.

CS 02505: Data Mining I 3 s.h.
This is a first graduate level course in Data Mining, which is designed to teach students the key steps in data mining, along with the primary algorithms related to data acquisition, cleansing, and supervised and unsupervised learning.

CS 02530: Advanced Database Systems: Theory and Programming 3 s.h.
This course focuses on the design of DBMS and their use to create databases. The course covers both the theoretical concepts and the implementation aspects of database systems with a special emphasis on relational database systems, SQL, programming (in a modern programming language such as C++ or Java) using a real database Application Programming Interface (such as JDBC or ODBC).

CS 02570: Information Visualization 3 s.h.
This is a graduate level course in Information Visualization. Topics covered include graphics programming, information visualization general principles, visualization techniques for 1-dimensional, 2-dimensional, and N-dimensional information,graph visualization, visualization techniques for image and digital libraries, as well as for the World Wide Web, interactivity,theories behind information visualization, and focus+context techniques. This course also includes the implementation oftechniques presented in lecture. Students are encouraged to devise new techniques, implement them, and determine theireffectiveness. Students will be required to complete in-depth assignments, read, summarize, and present recent journalpapers from the information visualization literature, and prepare term papers with regard to an information visualizationresearch topic. Students will also be required to specify, design, implement, and document a semester-long software projectrelated to information visualization.

CS 02605: Data Mining II 3 s.h.
Prerequisite: CS 02505 minimum Grade of D-
This course follows Data Mining I which is designed to train students in the necessary algorithms for extracting intelligence from large datasets. In Data Mining II, more advanced topics are covered including advanced clustering techniques, Principal Component Analysis, Naïve Bayes clustering and other techniques.

CS 02620: Data Warehousing 3 s.h.
Prerequisites: CS 02530
This course is designed to teach students data modeling, enterprise data integration, and other issues related to managing massive data sets necessary for data mining for business intelligence. The course focuses on data warehousing and cloud storage, with an emphasis on modeling and architectures, and their application to decision support.

CS 02625: Data Quality and Web Text Mining 3 s.h.
Prerequisites: CS 02530
This course studies data quality problems and solutions in the context of text and web mining, which is the exploration of vast amounts of digitized text for use in knowledge discovery or more particularly drug discovery in the biomedical field.

CS 02630 Advanced Topics in Database Systems
Prerequisite: CS 02530
This course will introduce a broad spectrum of database technologies with a particular focus on NoSQL systems. Contrasting database approaches will be assessed and evaluated. Topics discussed will be advanced and contemporary, and selected from areas such as distributed databases, sharding, principles of physical data storage, use of publishing/subscribe models, blob storage, geospatial and time-sequence databases, and object-relational modeling. Students will be expected to deliver applications in a variety of modern databases and critically analyze scholarly database articles.

CS 03500: Foundations of Cybersecurity 3 s.h.
This course introduces students to the fundamental cybersecurity concepts and provides students with basic security design principles and fundamentals. The topics of the course also include the components and their functions of an information technology system, cyber threats and different types of attacks and attackers, and application of forensics techniques to investigate and analyze network traffic.

CS 03506: Cybersecurity Management, Policy, and Risk 3 s.h.
This course covers cybersecurity planning and management, security risk analysis, policy, legal, ethics and compliance issues and security program management from a technical cybersecurity perspective.

CS 03551: Advanced Cyber Security: Principles and Applications 3 s.h.
Prerequisite(s): None
This graduate course examines the principles of cyber security and will introduce students to a wide range of security activities, methodologies, and procedures. The topics covered in the course include fundamental concepts of computer security: threats, attacks, and assets; principles of cryptography: encryption, decryption, authentication, and non-repudiation; software security and trusted systems: developing secure software, buffer overflow attacks, operatingsecurity issues, trusted systems; network security: intrusion detection, firewalls and intrusion prevention systems,distributed denial-of-service attacks, malicious software, protocols for network security; as well as other topics.

CS 03570: Cyber Defense of Operating Systems and Networks 3 s.h.
Pre-requisites: CS 01501 and CS 01502
This course covers an in depth look on the role of operating system security, its basic functions, and the services it provides related to cyber attacks. Students will become familiar with typical network cyber attacks and their defenses as well as how these attacks can influence the behavior of an operating system. Students will also learn how to assess the security capabilities of a computing system using some standard evaluation criteria (such as the Trusted Computer System Evaluation Criteria used by the Department of Defense). Students will then learn to improve the robustness of an operating system by applying methods related to managing applications, services and network ports to harden an operating system. At least one open source operating system's capabilities will be studied as it relates to the chosen standard evaluation criteria.

CS 03580: Cloud Computing and the Internet of Things – Architecture and Security 3 s.h.
This course studies the essential characteristics and services of cloud platforms, their security, their internal structure, and their possibilities and limitations. It provides hands-on experiences in areas such as cloud infrastructure components, security implications of cloud resources, typical instruction sets and architectures of embedded systems, IoT system architectures, IoT networking and security, MQTT and REST protocols, cyber considerations and issues related to embedded systems and IoT devices.

CS 04515: Embedded Systems Programming 3 s.h.

Embedded software is used in almost every electronic device. This course deals with software issues that arise in embedded systems programming. Important concepts covered in this course will include device programming interfaces, device drivers, multi-tasking with real-time constraints, task synchronization, device testing and debugging, and embeddedsoftware development tools such as emulators and debuggers. These concepts will be applied to design and implementembedded software for one or more modest-sized embedded systems

CS 04524: Agile Software Engineering 3 s.h.

Prerequisites: Computer Science graduate standing.

In this, course students apply in-depth techniques and experience various roles incorporated into the agile software engineering methodology. Ann overview of each of the major software engineering phases is provided and then applied towards the development of faster and more adaptable software. Proficiency in programming is expected of the students entering this course. Students are required to complete in-depth assignments, read, summarize, and present recent journal papers from the agile software engineering literature, and prepare term papers with regard to an agile software engineering research topic.

CS 04548: Programming Languages: Theory, Implementation and Application 3 s.h.An intermediate course intended to acquaint the student with the major categories of programming languages and to familiarize the student with one or two languages in each category. The student will complete programming projects in the languages studied. In addition, the student will learn formal mechanisms for specifying the syntax and semantics of languages and techniques for implementing data and control structures.

CS 04563: Concurrent Programming - Theory and Practice 3 s.h.

Prerequisites: Graduate Standing or Permission of the Instructor.

This course covers the fundamental concepts of concurrent programming: processes, threads, context switching, atomic instructions/actions, shared data, race conditions, critical sections, mutual exclusion, synchronization, locks, barriers, semaphores, monitors, and rendezvous. Hardware platforms are discussed: shared-memory multiprocessors, multiple CPUs, multiple GPUs. Multithreaded programming languages are described.

CS 04564: Compiler Design Theory 3 s.h.

Prerequisites: Acceptance into the Computer Science MS or BS/MS program

This course centers on the design and use of compilers, the sophisticated computer programs whose function is to translate high-level code to machine language. The following topics are covered: Compiler models, finite state machines, the lexical box, context free grammars, translation grammars, pushdown machines, the syntax box, and the code generator.

CS 04565: System Programming 3 s.h.

This course covers the internal structures and algorithms of the system kernel of a modern operating system as well as the system call interface to the kernel. Students will gain hands-on experience in system level programming in a modern operating system environment. The emphasis will be on interprocess communications and concurrency. The concept of distributed and client/server computing will also be introduced.

CS 04571: Advanced Topics in Mobile Programming 3 s.h.

Prerequisite(s): CS 04422 and CS 04471

Students will explore advanced topics in mobile application development. This course explores mobile application genres and the various development tools, languages and environments which are used to create them. The subject starts by requiring students to investigate the mobile application landscape and study some general purpose software development issues and techniques. It then requires each students to choose one of three implementation platforms: iOS (for Apple iPhone), .NET (for Windows Phone 7) or Java (for Android) and to study application development for that platform, implementing a modest application as a core requirement of their study. The subject concludes by looking, in theory, at the different deployment and distribution mechanisms used by mobile application vendors.

CS 04590: Computer Game Design and Development 3 s.h.

Prerequisites: Acceptance into the Computer Science MS or BS/MS program

This is a graduate level course that investigates advances in technology, science, art, and culture involved in the creation of computer games. Games will be examined in a systems context to understand gaming and game design fundamentals. Students will be required to complete in-depth assignments and present recent conference or journal papers from the computer gaming and game design fundamentals. Students will be required to complete in-depth assignments and presentrecent conference or journal papers from the computer gaming literature. Extensive study of past and current games will beused to illustrate course concepts. Students will also be required to specify, design, implement, and document asemester-long software project related to computer animation.

CS 04605: Advanced Web Programming 3 s.h.
Prerequisites: CS 02530
This course teaches students to create and modify sophisticated data-driven web pages using client-server architecture. Topics covered include non-text information such as video, images, sound, custom web applications, asynchronous communication, accessibility, searching, security, and web server configuration.

CS 04623: Advanced Software Engineering 3 s.h.
Prerequisites: CS 04524
Students will apply their knowledge from Software Engineering to develop an advanced software system, working in teams. The project will be taken through each of the major software development phases, and student teams will create appropriate deliverables for each phase. Advanced modern software engineering topics such as critical systems, real-time systems, formal specification and validation, and project management will be covered. Students will be required to complete in-depth assignments involving conference or journal papers from the software engineering literature.

CS 04670: Advanced Object Oriented Design 3 s.h.
Prerequisites: CS 04524
This course will introduce important concepts such as inheritance and polymorphism, which are crucial tools needed for crafting object-oriented solutions to real-world problems. Design patterns that commonly occur in design situations will becovered. A formal notation for describing and evaluating object-oriented designs such as the Unified Modeling Language(UML) will be taught. Students will apply the concepts to design and implement object oriented solutions to one or morereasonably sized real-world problems.

CS 06520: Topics In Computer Architecture 3 s.h.
Students in this course will study the various performance enhancement techniques and more advanced architectural features of modern computer systems. The topics include DMA, I/O processor, RAID, cache memory, virtual memory, pipelining, RISC, superscalar processors and various advanced parallel architectures such as array processors, vector processors, shared-memory multiprocessors, and message-passing multicomputers. Students will complete independent research projects that may include detailed examination of one or two contemporary computers.

CS 06560: Design/Implement Operation Systems 3 s.h.
Design choices and implementation (algorithms and data structures) of the capabilities of a modern operating system, including processes, concurrency, multithreading, synchronization, multiprocessors, CPU scheduling, interrupt handling, deadlocks, memory management, secondary storage management, file systems, I/O, protection and security. Issues include simplicity, efficiency, abstraction, microkernel, monolithic, client-server, mechanism vs. policy, caching.

CS 07510 Mathematical Foundations of Computer Science 3 s.h.
This course provides a graduate-level introduction to the theoretical foundations of computer science, including finite automata, context-free grammars, Turing machines, and formal logic.

CS 07530: Computer Science Thesis I 3 s.h.
In consultation with the instructor, students will identify and research a specific area of computer science or computer science education. Students will define a thesis project and develop a formal specification of their intended project for completion in Computer Science Thesis II.

CS 07531: Computer Science Thesis II 3 s.h.
Students will follow their formal project specification developed in Computer Science Thesis I to research a specific areaof computer science or computer science education and produce a written thesis.

CS 07532: Computer Science Thesis III 3 s.h.
Prerequisite: CS 07530 AND CS 07531
Students will continue scholarly research that was being done in Computer Science Thesis II and produce a written thesis.

CS 07540: Advanced Design and Analysis of Algorithms 3 s.h.
Students in this course will study efficient algorithms for sorting, searching, graphs, sets, matrices, and other applications, and will learn to design and analyze new algorithms. Students will also learn to recognize and prove NP-Completeness.

CS 07556: Machine Learning I 3 s.h.
This course introduces students to machine learning tasks at the graduate level including classification, regression, learning with unlabeled data), common machine learning approaches, and mathematics required to understand advanced topics in machine learning. Students will be exposed to topics such as data Issues in machine learning, Information-based learning (Decision Tree), Similarity-based learning (k-nearest neighbor), Probabilistic-based learning (naïve Bayes, Maximum A Posteriori, Bayesian Network), Linear Models (Perceptron, Linear Regression, Logistic Regression), Support Vector Machine, Neural Network, Performance measure and evaluation, Descriptive Statistics and Result Visualization, Learning with unlabeled data (clustering), Mathematics for Advanced Topics in Machine Learning (Topics in Probability, Linear Algebra, and Optimization).

CS 07565: Computer Vision 3 s.h.
This course examines the fundamental issues in computer vision and major approaches that address them. The topics include image formation, image filtering and transforms, image features, mathematical morphology, segmentation, and object recognition. More advanced topics such as camera calibration, stereopsis, dynamic vision, and computer architectures for vision will also be covered. Independent projects on these advanced topics will be required.

CS 07595: Advanced Topics in Computer Science 1 to 4 s.h.
This course enables the faculty to offer courses in advanced topics which are not offered on a regular basis. Prerequisites will vary according to the specific topic being studied.

CS 07622: Advanced Theory of Computing 3 s.h.
Prerequisites: CS 07510
This course builds on the introduction to the theory of computing provided in the course Foundations of Computer Science. It discusses finite automata, formal languages, Turing Machines, and computability theory at an advanced level

CS 07645: Advanced Robotics 3 s.h.
Prerequisites: CS 07540
This course provides an introduction to the fundamentals of robotics. Students study robot manipulators and mobile robots, robot sensors and robot cognition. Students will also gain experience programming in small groups, and programming in a domain where noisy and imprecise data is commonplace. Familiarity with matrix multiplication and inversion is expected for this course.

CS 07650: Concepts In Artificial Intelligence 3 s.h.
Prerequisites: CS 07540
This course surveys methods for programming computers to behave intelligently. Topics include knowledge representation methods, heuristic search, theorem-proving, puzzle-solving, game-playing, natural language processing, and expert systems.

CS 07652: Cryptographic Algorithms 3 s.h.
Prerequisite(s): CS 07540
This graduate course examines the advanced topics in the field of cryptography. The course will introduce students to a wide range of topics ranging from mathematical foundations to designing cryptographic algorithms. The topics covered inthe course will include the Data Encryption Standard (DES), Advanced Encryption Standard (AES), RSA cryptosystem, ElGamal cryptosystem, elliptic curve cryptosystem, integrity, authentication and key management, cryptographic hash functions, digital signatures, entity authentication, Kerberos, and others.

CS 07655: Natural Language Processing 3 s.h.
Prerequisites: CS 07540
This course presents methods for allowing computers to understand and generate sentences in human languages (such as English) and prepares the student to do research in natural language processing. Topics include syntax, semantics, pragmatics, and knowledge representation.

CS 07656: Machine Learning II 3 s.h.
Prerequisite: CS 07556
This course examines the mathematics and theory behind of some Machine Learning approaches, fundamental issues in machine learning, basic learning theory, and recent topics in machine learning. Topics may include Learning problem, Linear Models (Perceptron, Linear Regression, Logistic Regression), Support Machine Learning, Neural Network, Deep Learning, Ensemble method, Theory of Generalization (VC-dimension, Bias and Variance), Regularization, Validation, Dimension Reduction (Principal Component Analysis), and other recent topics in machine learning. This course builds onthe materials covered in CS 07556: Machine Learning I.

CS 08560: Computer Graphics 3 s.h.

Prerequisites: Acceptance into the Computer Science MS or BS/MS program

This is a graduate level course in Computer Graphics. Students will study the use and implementation of graphics packages. Techniques and algorithms for implementing graphics systems will be covered. They include drawing of 2-D primitives; 2- and 3-D transformation and viewing; representing curves and surfaces; hidden line and surface removal; illumination and shading. Substantial programming projects on writing graphics applications and implementing graphics algorithms will be assigned. Students are encouraged to devise new techniques, implement them, and determine their effectiveness. Students will be required to complete in-depth assignments involving conference or journal papers from the computer graphics literature.

CS 08680: Computer Animation 3 s.h.

Prerequisites: CS 08560

This is a graduate level course in Computer Animation that takes a look at Computer Animation from a programmer's perspective. It will investigate the theory, algorithms, and techniques for describing and programming motion for virtual 3D worlds. Approaches that will be explored include keyframing systems, kinematics, motion of articulated figures, and procedural and behavioral systems. Students will be required to complete in-depth assignments, read, summarize, and present recent journal papers from the computer animation literature, and prepare term papers with regard to a computer animation research topic. Students will also be required to specify, design, implement, and document a semester-long software project related to computer animation.

CS 09510: Computer Networks 3 s.h.

Prerequisites: Acceptance into the Computer Science MS or BS/MS program

Students in this course study how computer networks work and why they have been designed as we know them. The course covers descriptive material on network architectures and protocols, as well as network performance evaluation and protocol implementation. The course topics include important examples of local, metropolitan and wide area networks; telephone, cellular and wireless networks; the Internet; network security; and design tradeoffs in network systems and their implementations.

CS 09605: Wireless Networks and Systems 3 s.h.

Prerequisites: CS 09510

This course prepares students to understand wireless networks and systems, and the underlying communications technologies that make them possible. The course covers descriptive material on wireless communications technologies, and important deployed and proposed networks and systems. Wireless system performance and Quality of Servicecapabilities are addressed. Students will prepare and deliver technical presentations on state-of-the-art topics in wirelessnetworks and systems.

CS 09612: Network Security 3 s.h.

Prerequisites: CS 09510

This is a graduate level course that covers the fundamentals of network security and cryptology. The course will cover such topics as cryptographic systems necessary for security, public key infrastructure, principles of data integrity, authentication, and key management, Internet architecture and TCP/IP protocol suite, application layer security, secure sockets layer and transport layer security protocols, IPSec and distributed denial of service attacks. Students will prepare and deliver technical presentations on state-of-the-art research topics in network security.

CS 09675: Advanced TCP/IP and Internet Protocols and Technologies 3 s.h.

Prerequisites: CS 09510

This is an advanced computer networking course that will expand students' knowledge received in the Data Communications and Networking course. This course will examine operation of the TCP/IP protocol as well as design and architecture of the Internet. This course will cover such topics as: medium access protocols, address resolution protocols, Internet routing, Internet Protocol (IP), Quality of Service, Transport Protocol, and congestion control mechanisms. This course will also include selected topics on network security and network management. Students will prepare and deliver technical presentations on state-of-the-art research topics in the Internet.