Courses

COMPSCI 111. Digital Image Processing. 4 Units.
Introduction to the fundamental concepts of digital signal and image processing as applicable in areas such as multimedia, graphics, AI, data mining, databases, vision, or video games. Topics include image representation, space- and frequency-domain transformations, filters, segmentation, and compression.

Prerequisite: (I&C SCI 23 or CSE 23 or I&C SCI 46 or CSE 46) and I&C SCI 6D and (MATH 6G or MATH 3A or I&C SCI 6N). I&C SCI 23 with a grade of C or better. CSE 23 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better. I&C SCI 6D with a grade of C or better. MATH 6G with a grade of C or better. MATH 3A with a grade of C or better. I&C SCI 6N with a grade of C or better.

COMPSCI 112. Computer Graphics. 4 Units.
Introduction to the fundamental principles of 3D computer graphics including polygonal modeling, geometric transformations, visibility algorithms, illumination models, texturing, and rasterization. Use of an independently-learned 3D graphics API to implement these techniques.

Prerequisite: (I&C SCI 22 or CSE 22 or I&C SCI H22 or I&C SCI 33 or CSE 43) and (I&C SCI 45C or CSE 45C) and (MATH 6G or MATH 3A or I&C SCI 6N). I&C SCI 22 with a grade of C or better. CSE 22 with a grade of C or better. I&C SCI H22 with a grade of C or better. I&C SCI 33 with a grade of C or better. CSE 43 with a grade of C or better. I&C SCI 45C with a grade of C or better. CSE 45C with a grade of C or better. MATH 6G with a grade of C or better. MATH 3A with a grade of C or better. I&C SCI 6N with a grade of C or better.

COMPSCI 113. Computer Game Development. 4 Units.
Introduction to the principles of interactive 2D and 3D computer game development. Concepts in computer graphics, algorithms, software engineering, art and graphics, music and sound, story analysis, and artificial intelligence are presented and are the basis for student work.

Prerequisite: COMPSCI 112 or COMPSCI 171 or IN4MATX 121 or ART 106B or I&C SCI 163 or I&C SCI 166.

Same as IN4MATX 125.

COMPSCI 114. Projects in Advanced 3D Computer Graphics. 4 Units.
Projects in advanced 3D graphics such as illumination, geometric modeling, visualization, and animation. Topics may include physically based and global illumination, solid modeling, curved surfaces, multiresolution modeling, image-based rendering, basic concepts of animation, and scientific visualization.

Prerequisite: COMPSCI 112 and (I&C SCI 45C or CSE 45C). I&C SCI 45C with a grade of C or better. CSE 45C with a grade of C or better. Recommended: COMPSCI 161 or CSE 161 or COMPSCI 164 or COMPSCI 165.

COMPSCI 115. Computer Simulation. 4 Units.
Discrete event-driven simulation; continuous system simulation; basic probability as pertaining to input distributions and output analysis; stochastic and deterministic simulation; static and dynamic system simulation.

Prerequisite: I&C SCI 6B and (MATH 6G or I&C SCI 6N) and STATS 67 and I&C SCI 51 and (I&C SCI 52 or IN4MATX 43). I&C SCI 6B with a grade of C or better. MATH 6G with a grade of C or better. I&C SCI 6N with a grade of C or better. STATS 67 with a grade of C or better. I&C SCI 51 with a grade of C or better. I&C SCI 52 with a grade of C or better. IN4MATX 43 with a grade of C or better.

Restriction: Upper-division students only.

COMPSCI 116. Computational Photography and Vision. 4 Units.
Introduces the problems of computer vision through the application of computational photography. Specific topics include photo-editing (image warping, compositing, hole filling), panoramic image stitching, and face detection for digital photographs.

Prerequisite: I&C SCI 6D and (MATH 6G or MATH 3A or I&C SCI 6N) and MATH 2B and (I&C SCI 23 or CSE 23 or I&C SCI 46 or CSE 46). I&C SCI 6D with a grade of C or better. MATH 6G with a grade of C or better. MATH 3A with a grade of C or better. I&C SCI 6N with a grade of C or better. MATH 2B with a grade of C or better. I&C SCI 23 with a grade of C or better. CSE 23 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better.
COMPSCI 117. Project in Computer Vision. 4 Units.
Students undertake construction of a computer vision system. Topics may include automatically building 3D models from photographs, searching photo collections, robot navigation, and human motion tracking.

Prerequisite: I&C SCI 6D and (MATH 6G or MATH 3A or I&C SCI 6N) and MATH 2B and (I&C SCI 23 or CSE 23 or I&C SCI H23 or I&C SCI 46 or CSE 48) and (COMPSCI 112 or COMPSCI 116 or COMPSCI 171 or COMPSCI 178). I&C SCI 6D with a grade of C or better. MATH 6G with a grade of C or better. MATH 3A with a grade of C or better. I&C SCI 6N with a grade of C or better. MATH 2B with a grade of C or better. I&C SCI 23 with a grade of C or better. CSE 23 with a grade of C or better. I&C SCI H23 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better.

COMPSCI 121. Information Retrieval. 4 Units.
An introduction to information retrieval including indexing, retrieval, classifying, and clustering text and multimedia documents.

Prerequisite: (IN4MATX 45 or I&C SCI 46 or CSE 46 or ((I&C SCI 33 or CSE 43) and I&C SCI 45J)) and (STATS 7 or STATS 67). IN4MATX 45 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better. I&C SCI 33 with a grade of C or better. CSE 43 with a grade of C or better. I&C SCI 45J with a grade of C or better.

Same as IN4MATX 141.

COMPSCI 122A. Introduction to Data Management. 4 Units.
Introduction to the design of databases and the use of database management systems (DBMS) for applications. Topics include entity-relationship modeling for design, relational data model, relational algebra, relational design theory, and Structured Query Language (SQL) programming.

(Design units: 1)

Prerequisite: I&C SCI 23 or CSE 23 or I&C SCI H23 or I&C SCI 46 or CSE 46 or IN4MATX 45 or I&C SCI 33 or CSE 43 or EECS 114. I&C SCI 23 with a grade of C or better CSE 23 with a grade of C or better I&C SCI H23 with a grade of C or better CSE 46 with a grade of C or better I&C SCI 46 with a grade of C or better CSE 43 with a grade of C or better I&C SCI 33 with a grade of C or better CSE 43 with a grade of C or better

Same as EECS 116.

Restriction: School of Information and Computer Sciences majors and Computer Engineering majors have first consideration for enrollment.

COMPSCI 122B. Project in Databases and Web Applications. 4 Units.
Introduces students to advanced database technologies and Web applications. Topics include but are not limited to database connectivity (ODBC/ JDBC), extending databases using stored procedures, database administration, Web servers, Web programming languages (Java servlets, XML, Ajax, and mobile platforms).

Prerequisite: (COMPSCI 122A or EECS 116) and I&C SCI 45J.

COMPSCI 122C. Principles of Data Management. 4 Units.
Covers fundamental principles underlying data management systems. Content includes key techniques including storage management, buffer management, record-oriented file system, access methods, query optimization, and query processing.

Prerequisite: COMPSCI 122A and COMPSCI 143A and COMPSCI 152.

Concurrent with COMPSCI 222.

COMPSCI 125. Next Generation Search Systems. 4 Units.
Discusses concepts and techniques related to all aspects of search systems. After considering basic search technology and the state-of-art systems, rapidly developing techniques for multimedia search, local search, event-search, and video-on-demand are explored.

Prerequisite: I&C SCI 21 or CSE 21 or IN4MATX 41 or I&C SCI 31 or IN4MATX 41.

Restriction: Upper-division students only.

Concurrent with COMPSCI 225.

COMPSCI 131. Parallel and Distributed Computing. 4 Units.
Parallel and distributed computer systems. Parallel programming models. Common parallel and distributed programming issues. Specific topics covered include parallel programming, performance models, coordination and synchronization, consistency and replication, transactions, fault tolerance.

Prerequisite: I&C SCI 53 and I&C SCI 53L and I&C SCI 45C.
COMPSCI 132. Computer Networks. 4 Units.
Computer network architectures, protocols, and applications. Internet congestion control, addressing, and routing. Local area networks. Multimedia networking.

(Design units: 2)
Prerequisite: EECS 55 or STATS 67.

Same as EECS 148.

Restriction: Computer Engineering and Computer Science and Engineering majors have first consideration for enrollment.

COMPSCI 133. Advanced Computer Networks. 4 Units.
Fundamental principles in computer networks are applied to obtain practical experience and skills necessary for designing and implementing computer networks, protocols, and network applications. Various network design techniques, simulation techniques, and UNIX network programming are covered.

Prerequisite: COMPSCI 132.

COMPSCI 134. Computer and Network Security. 4 Units.
Overview of modern computer and networks security, attacks, and countermeasures. Authentication, identification, data secrecy, data integrity, authorization, access control, computer viruses, network security. Also covers secure e-commerce and applications of public key methods, digital certificates, and credentials.

Prerequisite: I&C SCI 60 and (I&C SCI 33 or CSE 43 or I&C SCI 22 or CSE 22 or IN4MATX 42) and (COMPSCI 122A or EECS 116 or COMPSCI 132 or COMPSCI 143A or CSE 104).

COMPSCI 137. Internet Applications Engineering. 4 Units.
Concepts in Internet applications engineering with emphasis on the Web. Peer-to-Peer and Interoperability. Topics include HTTP and REST, Remote Procedure/Method Calls, Web Services, data representations, content distribution networks, identity management, relevant W3C/IETF standards, and relevant new large-scale computing styles.

Prerequisite: COMPSCI 132.

Same as IN4MATX 124.

Restriction: Upper-division students only.

COMPSCI 141. Concepts in Programming Languages I. 4 Units.
In-depth study of several contemporary programming languages stressing variety in data structures, operations, notation, and control. Examination of different programming paradigms, such as logic programming, functional programming and object-oriented programming; implementation strategies, programming environments, and programming style. Course may be offered online.

Prerequisite: (IN4MATX 42 or I&C SCI 51 or CSE 31 or EECS 31) and (IN4MATX 45 or I&C SCI 46 or CSE 46 or I&C SCI 33 or CSE 43). IN4MATX 42 with a grade of C or better. I&C SCI 51 with a grade of C or better. CSE 31 with a grade of C or better. EECS 31 with a grade of C or better. IN4MATX 45 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better. I&C SCI 33 with a grade of C or better. CSE 43 with a grade of C or better.

Same as IN4MATX 101, CSE 141.

COMPSCI 142A. Compilers and Interpreters. 4 Units.
Introduction to the theory of programming language processors covering lexical analysis, syntax analysis, semantic analysis, intermediate representations, code generation, optimization, interpretation, and run-time support.

Prerequisite: CSE 141 or COMPSCI 141 or IN4MATX 101.

Same as CSE 142.

COMPSCI 142B. Language Processor Construction. 4 Units.
Project course which provides working laboratory experience with construction and behavior of compilers and interpreters. Students build actual language processors and perform experiments which reveal their behaviors.

Prerequisite: COMPSCI 142A or CSE 142.
COMPSCI 143A. Principles of Operating Systems. 4 Units.
Principles and concepts of process and resource management, especially as seen in operating systems. Processes, memory management, protection, scheduling, file systems, and I/O systems are covered. Concepts illustrated in the context of several well-known systems. Course may be offered online. Course may be offered online.
Prerequisite: (I&C SCI 23 or CSE 23 or I&C SCI 46 or CSE 46) and (I&C SCI 51 or EECS 31 or CSE 31).
Overlaps with EECS 111.

COMPSCI 143B. Project in Operating System Organization. 4 Units.
Detailed specification and design of critical components of an actual operating system including a memory manager, a process server, and a file/I/O subsystem. Hardware/software tradeoffs. Emphasis on logical organization of system and communication.
Prerequisite: COMPSCI 143A or CSE 104.

COMPSCI 144. High-performance Computers and Program Optimization. 4 Units.
Analyzes the relationship between computer architecture and program optimization. High-performance and parallelizing compilers for RISC, Superscalar, and VLIW architectures are discussed.
Prerequisite: I&C SCI 51. Recommended: COMPSCI 142A. I&C SCI 51 with a grade of C or better.

COMPSCI 145A. Embedded Computing Systems. 4 Units.
Principles of embedded computing systems: embedded systems architecture, hardware/software components, system software and interfacing, real-time operating systems, hardware/software co-development, and communication issues. Examples of embedded computing in real-world application domains. Simple programming using an embedded systems development environment.
Corequisite: COMPSCI 145B.
Prerequisite: (CSE 46 or I&C SCI 46 or CSE 23 or I&C SCI 23 or I&C SCI 51 or CSE 31 or EECS 31).
Same as CSE 145A.

COMPSCI 145B. Embedded Computing System Lab. 2 Units.
Laboratory section to accompany CSE 145A or COMPSCI 145A.
(Design units: 0)
Corequisite: CSE145A or COMPSCI 145A.
Same as CSE 145B.

COMPSCI 146. Programming in Multitasking Operating Systems. 4 Units.
User- and systems-level programming of modern Internet-connected, multi-user, multitasking operating systems. Shells, scripting, filters, pipelines, programmability, extensibility, concurrency, inter-process communication. Concrete examples of a modern operating system (such as, but not necessarily, Unix programmed in C) are used.
Prerequisite: (I&C SCI 23 or CSE 23 or I&C SCI 46 or CSE 46) and I&C SCI 51. I&C SCI 23 with a grade of C or better. CSE 23 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better. I&C SCI 51 with a grade of C or better. Recommended: COMPSCI 143A.

COMPSCI 151. Digital Logic Design. 4 Units.
Prerequisite: (I&C SCI 33 or CSE 43 or I&C SCI 23 or CSE 43) and I&C SCI 51 and I&C SCI 6B and I&C SCI 6D. I&C SCI 33 with a grade of C or better. CSE 43 with a grade of C or better. I&C SCI 23 with a grade of C or better. CSE 43 with a grade of C or better. I&C SCI 51 with a grade of C or better.

COMPSCI 152. Computer Systems Architecture. 4 Units.
Design of computer elements; ALU, control unit, and arithmetic circuits. Memory hierarchy and organization. Caches. Function unit sharing and pipelining. I/O and interrupt processing. RTL and behavioral modeling using hardware description languages. Microprocessor organization and implementation techniques.
Prerequisite: COMPSCI 151.
Overlaps with I&C SCI 160, EECS 112.
COMPSCI 153. Logic Design Laboratory. 4 Units.
Introduction to standard integrated circuits. Construction and debugging techniques. Design of digital systems using LSI and MSI components. Practical use of circuits in a laboratory environment, including implementation of small digital systems such as arithmetic modules, displays, and timers.
Prerequisite: COMPSCI 151.

COMPSCI 154. Computer Design Laboratory. 4 Units.
Underlying primitives of computer instruction sets. Principles of microprogramming. Microprogramming. Microprograms written for one or more systems. Typical microprogramming applications discussed and implemented or simulated.
Prerequisite: Prerequisite or corequisite: COMPSCI 151.

COMPSCI 161. Design and Analysis of Algorithms. 4 Units.
Techniques for efficient algorithm design, including divide-and-conquer and dynamic programming, and time/space analysis. Fast algorithms for problems applicable to networks, computer games, and scientific computing, such as sorting, shortest paths, minimum spanning trees, network flow, and pattern matching.
Prerequisite: (I&C SCI 23 or CSE 23 or I&C SCI 46 or CSE 46) and I&C SCI 6B and I&C SCI 6D and MATH 2B. I&C SCI 23 with a grade of C or better. CSE 23 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better.

COMPSCI 162. Formal Languages and Automata. 4 Units.
Formal aspects of describing and recognizing languages by grammars and automata. Parsing regular and context-free languages. Ambiguity, nondeterminism. Elements of computability; Turning machines, random access machines, undecidable problems, NP-completeness.
Prerequisite: (I&C SCI 23 or CSE 23 or I&C SCI 46 or CSE 46) and MATH 2A and MATH 2B and I&C SCI 6B and I&C SCI 6D. I&C SCI 23 with a grade of C or better. CSE 23 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better.

COMPSCI 163. Graph Algorithms. 4 Units.
Algorithms for solving fundamental problems in graph theory. Graph representations, graph traversal, network flow, connectivity, graph layout, matching problems.
Prerequisite: COMPSCI 161 or CSE 161.

COMPSCI 164. Computational Geometry and Geometric Modeling. 4 Units.
Algorithms and data structures for computational geometry and geometric modeling, with applications to game and graphics programming. Topics: convex hulls, Voronoi diagrams, algorithms for triangulation, motion planning, and data structures for geometric searching and modeling of 2D and 3D objects.
Prerequisite: I&C SCI 23 or CSE 23 or I&C SCI H23 or I&C SCI 46 or CSE 46. I&C SCI 23 with a grade of C or better. CSE 23 with a grade of C or better. I&C SCI 46 with a grade of C or better. CSE 46 with a grade of C or better.

COMPSCI 165. Project In Algorithms And Data Structures. 4 Units.
Design, implementation, execution, and analysis of algorithms for problems such as sorting, searching, data compression, and data encryption. Time-space-structure trade-offs.
Prerequisite: COMPSCI 161 or CSE 161. Recommended: I&C SCI 45C OR CSE 45C.

COMPSCI 166. Network Optimization. 4 Units.
Network modeling techniques and related algorithms for solving large-scale integer programming problems. Exact methods and heuristic techniques. Applications include computer and communications networks and transportation and logistics networks.
Restriction: Upper-division students only.

COMPSCI 167. Introduction to Applied Cryptography. 4 Units.
An introduction to the essential aspects of applied cryptography, as it is used in practice. Topics include classical cryptography, block ciphers, stream ciphers, public-key cryptography, digital signatures, one-way hash functions, basic cryptographic protocols, and digital certificates and credentials.
Prerequisite: COMPSCI 161 or CSE 161.
Restriction: Upper-division students only.
COMPSCI 169. Introduction to Optimization. 4 Units.
Prerequisite: (I&C SCI 6N or MATH 3A or MATH 6G) and STATS 67.
Concurrent with COMPSCI 268.

COMPSCI 171. Introduction to Artificial Intelligence. 4 Units.
Different means of representing knowledge and uses of representations in heuristic problem solving. Representations considered include predicate logic, semantic nets, procedural representations, natural language grammars, and search trees.
Corequisite: STATS 67.
Prerequisite: (I&C SCI 23 or CSE 23 or I&C SCI 46 or CSE 46) and MATH 2B.

COMPSCI 172B. Neural Networks and Deep Learning. 4 Units.
Neural network and deep learning from multiple perspectives. Theory of parallel distributed processing systems, algorithmic approaches for learning from data in various manners, applications to difficult problems in AI from computer vision, to natural language understanding, to bioinformatics and chemoinformatics.
Prerequisite: STATS 120A and STATS 120B, or MATH 121A, or COMPSCI 178, or COMPSCI 273A, or equivalents.
Concurrent with COMPSCI 274C.

COMPSCI 174. Bioinformatics. 4 Units.
Introduces fundamental problems in biology that lend themselves to computational approaches. The lectures present the necessary biological background to understand the importance of the problem and the data available for algorithmic analysis.
Prerequisite: COMPSCI 171. COMPSCI 171 with a grade of C or better.

COMPSCI 175. Project in Artificial Intelligence. 4 Units.
Construction of a working artificial intelligence system. Evaluation of capabilities of the system including impact of knowledge representation.
Prerequisite: COMPSCI 171.

COMPSCI 177. Applications of Probability in Computer Science. 4 Units.
Application of probability to real-world problems in computer science. Typical topics include analysis of algorithms and graphs, probabilistic language models, network traffic modeling, data compression, and reliability modeling.
Prerequisite: MATH 2B and STATS 67 and I&C SCI 6B and I&C SCI 6D and (MATH 6G or MATH 3A or I&C SCI 6N).

COMPSCI 178. Machine Learning and Data-Mining. 4 Units.
Introduction to principles of machine learning and data mining applied to real-world datasets. Typical applications include spam filtering, object recognition, and credit scoring.
Prerequisite: I&C SCI 6B and I&C SCI 6D and (I&C SCI 6N or MATH 6G or MATH 3A and I&C SCI 6N) and MATH 2B and STATS 67.

COMPSCI 179. Algorithms for Probabilistic and Deterministic Graphical Models. 4 Units.
Graphical model techniques dealing with probabilistic and deterministic knowledge representations. Focuses on graphical models, such as constraint networks, Bayesian networks and Markov networks that have become a central paradigm for knowledge representation and reasoning in Artificial Intelligence and general computer science.
Prerequisite: I&C SCI 23 or CSE 23 or I&C SCI 46 or (CSE 46 and MATH 2A and MATH 2B and STATS 67)
Restriction: Prerequisite required

COMPSCI 183. Introduction to Computational Biology. 4 Units.
Prerequisite: MATH 2D or MATH 2J or STATS 7 or STATS 8.
Same as BIO SCI M123.
Concurrent with MOL BIO 223.
COMPSCI 184A. Representations and Algorithms for Molecular Biology. 4 Units.
Introduction to computational methods in molecular biology, aimed at those interested in learning about this interdisciplinary area. Covers computational approaches to understanding and predicting the structure, function, interactions, and evolution of DNA, RNA, proteins, and related molecules and processes.
Prerequisite: BIO SCI M123 or COMPSCI 183.
Concurrent with COMPSCI 284A.

COMPSCI 184B. Probabilistic Modeling of Biological Data. 4 Units.
A unified Bayesian probabilistic framework for modeling and mining biological data. Applications range from sequence (DNA, RNA, proteins) to gene expression data. Graphical models, Markov models, stochastic grammars, structure prediction, gene finding, evolution, DNA arrays, single- and multiple-gene analysis.
Prerequisite: COMPSCI 184A.
Concurrent with COMPSCI 284B.

COMPSCI 184C. Computational Systems Biology. 4 Units.
Prerequisite: COMPSCI 184A.
Concurrent with COMPSCI 284C.

COMPSCI 189. Project in Bioinformatics. 4 Units.
Teaches problem definition and analysis, data representation, algorithm design, component integration, solution validation, and testability with teams specifying, designing, building, and testing a solution to a bioinformatics problem. Lectures include engineering values, discussions, and ethical ramifications of biomedical computing issues.
Prerequisite: COMPSCI 184A. COMPSCI 184A with a grade of C or better.

COMPSCI 190. Special Topics in Information and Computer Science. 4 Units.
Studies in selected areas of Information and Computer Science. Topics addressed vary each quarter.
Prerequisite: Prerequisites vary.
Repeatability: Unlimited as topics vary.

COMPSCI H198. Honors Research. 4 Units.
Directed independent research in computer science for honors students.
Prerequisite: Satisfactory completion of the Lower-Division Writing requirement.
Repeatability: May be repeated for credit unlimited times.
Restriction: Upper-division students only. Bren School of ICS Honors Program or Campuswide Honors Program students only.

COMPSCI 199. Individual Study. 2-5 Units.
Individual research or investigation with Computer Science faculty.
Repeatability: May be repeated for credit unlimited times.

COMPSCI 200S. Seminar in Computer Science Research. 1 Unit.
Graduate colloquium series. Includes weekly talks by notable computer scientists.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

COMPSCI 201. Foundations of Cryptographic Protocols. 4 Units.
Explores fundamental cryptographic tools, including encryption, signatures, and identification schemes. Students are introduced to the provable security paradigm of modern cryptography, focusing on understanding of security properties provided by cryptographic tools, and on proving security (or insecurity) of cryptographic constructions.
Prerequisite: COMPSCI 260 or COMPSCI 263.
COMPSCI 202. Applied Cryptography. 4 Units.
Design and analysis of algorithms for applied cryptography. Topics include symmetric and asymmetric key encryption, digital signatures, one-way hash functions, digital certificates and credentials, and techniques for authorization, non-repudiation, authentication, identification, data integrity, proofs of knowledge, and access control.
Prerequisite: COMPSCI 260 and COMPSCI 263.

COMPSCI 203. Network and Distributed Systems Security. 4 Units.
Modern computer and networks security: attacks and countermeasures, authentication, identification, data secrecy, data integrity, authorization, access control, computer viruses, network security. Group communication and multicast security techniques. Covers secure e-commerce and applications of public key methods, digital certificates, and credentials.
Prerequisite: EECS 148 or COMPSCI 132.
Same as NET SYS 240.

COMPSCI 206. Principles of Scientific Computing. 4 Units.
Overview of widely used principles and methods of numerical and scientific computing, including basic concepts and computational methods in linear algebra, optimization, and probability.
Prerequisite: Basic courses in multivariate calculus, linear algebra, and probability.
Overlaps with STATS 230.

COMPSCI 211A. Visual Computing. 4 Units.
Fundamentals of image processing (convolution, linear filters, spectral analysis), vision geometry (projective geometry, camera models and calibration, stereo reconstruction), radiometry (color, shading, illumination, BRDF), and visual content synthesis (graphics pipeline, texture- bump-, mip-mapping, hidden surface removal, anti-aliasing).

COMPSCI 211B. Computer Graphics and Visualization. 4 Units.
Advanced topics in 3D graphics on rendering, geometric modeling, and visualization. Subjects range from illumination and shading, and multiresolution representations, to other advanced algorithms and data structures in graphics. Also looks at trends that go beyond traditional computer graphics.
Prerequisite: COMPSCI 211A.

COMPSCI 212. Multimedia Systems and Applications. 4 Units.
Organization and structure of modern multimedia systems; audio and video encoding/compression; quality of service concepts; scheduling algorithms for multimedia; resource management in distributed and multimedia systems; multimedia protocols over high-speed networks; synchronization schemes; multimedia applications and teleservices.
Prerequisite: (COMPSCI 143A and COMPSCI 161) or B.S. degree in Computer Science. Recommended: COMPSCI 131 and COMPSCI 132 and COMPSCI 133.

COMPSCI 213. Introduction to Visual Perception. 4 Units.
Introduction to the process of human visual perception. Offers the physiological and psychophysical approach to understand vision, introducing concepts of perception of color, depth, movement. Examples of quantification and application of these models in computer vision, computer graphics, multimedia, HCI.
Prerequisite: MATH 121A.

COMPSCI 216. Image Understanding. 4 Units.
The goal of image understanding is to extract useful semantic information from image data. Course covers low-level image and video processing techniques, feature descriptors, segmentation, objection recognition, and tracking.
Prerequisite: I&C SCI 6D and (I&C SCI 6N or MATH 6G or MATH 3A) and MATH 2B and I&C SCI 46.

COMPSCI 217. Light and Geometry in Computer Vision. 4 Units.
Examines the issues of light transport and multiview geometry in computer vision. Applications include camera calibration, 3D understanding, stereo reconstruction, and illumination estimation.
Prerequisite: I&C SCI 6D and (I&C SCI 6N or MATH 6G or MATH 3A) and MATH 2B and I&C SCI 46 and COMPSCI 211A.
COMPSCI 221. Information Retrieval, Filtering, and Classification. 4 Units.
Algorithms for the storage, retrieval, filtering, and classification of textual and multimedia data. The vector space model, Boolean and probabilistic queries, and relevance feedback. Latent semantic indexing; collaborative filtering; and relationship to machine learning methods.

Prerequisite: COMPSCI 161 and COMPSCI 171 and (I&C SCI 6N or MATH 3A or MATH 6G).
Same as IN4MATX 225.
Restriction: Graduate students only.

COMPSCI 222. Principles of Data Management. 4 Units.
Covers fundamental principles underlying data management systems. Content includes key techniques including storage management, buffer management, record-oriented file system, access methods, query optimization, and query processing.

Prerequisite: COMPSCI 122A and COMPSCI 143A and COMPSCI 152.
Concurrent with COMPSCI 122C.

COMPSCI 223. Transaction Processing and Distributed Data Management. 4 Units.
Covers fundamental principles underlying transaction processing including database consistency, concurrency control, database recovery, and fault-tolerance. Includes transaction processing in centralized, distributed, parallel, and client-server environments.

Prerequisite: COMPSCI 222 and COMPSCI 131.

COMPSCI 224. Advanced Topics in Data Management. 4 Units.
Selected advanced topics in data management. Content differs in each offering and with instructor's interests. Intended for students interested in data management with focus on reading and critiquing recent research papers, presentations, and substantial research projects.

Prerequisite: COMPSCI 143A and COMPSCI 152 and COMPSCI 161 and COMPSCI 222 and COMPSCI 223.

COMPSCI 225. Next Generation Search Systems. 4 Units.
Discusses concepts and techniques related to all aspects of search systems. After considering basic search technology and the state-of-art systems, rapidly developing techniques for multimedia search, local search, event-search, and video-on-demand are explored.

Prerequisite: I&C SCI 21 or CSE 21 or IN4MATX 41 or I&C SCI 31 or CSE 41.
Restriction: Upper-division or Graduate students only.
Concurrent with COMPSCI 125.

COMPSCI 230. Distributed Computer Systems. 4 Units.
Principles of distributed computing systems. Topics covered include message-passing, remote procedure calls, distributed shared memory synchronization, resource and process/thread management, distributed file systems, naming and security.

COMPSCI 232. Computer and Communication Networks. 4 Units.

Prerequisite: EECS 148 or COMPSCI 132.
Same as EECS 248A, NET SYS 201.
Restriction: Graduate students only.

COMPSCI 233. Networking Laboratory. 4 Units.
A laboratory-based introduction to basic networking concepts such as addressing, sub-netting, bridging, ARP, and routing. Network simulation and design. Structured around weekly readings and laboratory assignments.

Prerequisite: EECS 148 or COMPSCI 132.
Same as NET SYS 202.
COMPSCI 234. Advanced Networks. 4 Units.
Design principles of networked systems, advanced routing and congestion control algorithms, network algorithms, network measurement, management, security, Internet economics, and emerging networks.

Prerequisite: NET SYS 201 or COMPSCI 232 OR EECS 248A.

Same as NET SYS 210.

COMPSCI 236. Wireless and Mobile Networking. 4 Units.
Introduction to wireless networking. The focus is on layers 2 and 3 of the OSI reference model, design, performance analysis, and protocols. Topics covered include: an introduction to wireless networking, digital cellular, next generation cellular, wireless LANs, and mobile IP.

Prerequisite: EECS 148 or COMPSCI 132.

Same as NET SYS 230.

COMPSCI 237. Middleware for Networked and Distributed Systems. 4 Units.
Discusses concepts, techniques, and issues in developing distributed systems middleware that provides high performance and Quality of Service for emerging applications. Also covers existing standards (e.g., CORBA, DCOM, Jini, Espeak) and their relative advantages and shortcomings.

Prerequisite: An undergraduate-level course in operating systems and networks.

Same as NET SYS 260.

COMPSCI 240. Language-Based Security. 4 Units.
Teaches state-of-the-art language-based techniques for increasing the security and reliability of software systems. Covers static (e.g., bytecode verification, proof-carrying code) and dynamic (e.g., reference monitors, stack inspection) techniques. Also discusses information flow and securing legacy code.

Prerequisite: COMPSCI 230 or COMPSCI 242 or COMPSCI 262.

COMPSCI 241. Advanced Compiler Construction. 4 Units.
Advanced study of programming language implementation techniques: optimizations such as common sub-expression elimination, register allocation, and instruction scheduling. Implementation of language features such as type-directed dispatch, garbage collection, dynamic linking, and just-in-time code generation.

Prerequisite: COMPSCI 142A.

COMPSCI 242. Parallel Computing. 4 Units.

COMPSCI 243. High-Performance Architectures and Their Compilers. 4 Units.
Emphasis on the development of automatic tools (i.e., compilers/environments) for the efficient exploitation of parallel machines, and the trade-offs between hardware and software in the design of supercomputing and high-performance machines.

COMPSCI 244. Introduction to Embedded and Ubiquitous Systems. 4 Units.
Embedded and ubiquitous system technologies including processors, DSP, memory, and software. System interfacing basics; communication strategies; sensors and actuators, mobile and wireless technology. Using pre-designed hardware and software components. Design case studies in wireless, multimedia, and/or networking domains.

Prerequisite: I&C SCI 51 and COMPSCI 152 and COMPSCI 161 and (I&C SCI 6N or MATH 3A or MATH 6G or I&C SCI 6D) or B.S. degree in Computer Science.

Same as IN4MATX 244.

COMPSCI 245. Software for Embedded Systems. 4 Units.

Prerequisite: I&C SCI 51 and COMPSCI 152 and COMPSCI 161 and (I&C SCI 6N or MATH 3A or MATH 6G or I&C SCI 6D) or B.S. degree in Computer Science.
COMPSCI 246. Validation and Testing of Embedded Systems. 4 Units.

Prerequisite: B.S. degree in Computer Science or basic courses in algorithms & data structures, calculus, discrete math, linear algebra, symbolic logic.

COMPSCI 247. Design Automation and Prototyping of Embedded Systems. 4 Units.

Prerequisite: I&C SCI 6D and I&C SCI 51 and COMPSCI 152 and COMPSCI 161 and COMPSCI 244 and (I&C SCI 6N or MATH 3A or MATH 6G) or B.S. degree in Computer Science.

COMPSCI 248A. Introduction to Ubiquitous Computing. 4 Units.
The "disappearing computer" paradigm. Differences to the desktop computing model: applications, interaction in augmented environments, security, alternate media, small operating systems, sensors, and embedded systems design. Evaluation by project work and class participation.

Same as IN4MATX 241.

COMPSCI 248B. Ubiquitous Computing and Interaction. 4 Units.
Principles and design techniques for ubiquitous computing applications. Conceptual basis for tangible and embodied interaction. Interaction in virtual and augmented environments. Design methods and techniques. Design case studies. Examination by project work.

Prerequisite: IN4MATX 231 and IN4MATX 241.

Same as IN4MATX 242.

COMPSCI 249S. Seminar in Compilers and Operating Systems. 2 Units.
Current research and research trends in system-level software such as compilers and operating systems. Forum for presentation and criticism by students of new published research and work in progress.

Prerequisite: (COMPSCI 142A and COMPSCI 143A) or B.S. degree in Computer Science.

Repeatability: May be taken for credit 4 times.

COMPSCI 250A. Computer Systems Architecture. 4 Units.
Study of architectural issues and their relation to technology and software: design of processor, interconnections, and memory hierarchies.

Prerequisite: COMPSCI 152.

COMPSCI 250B. Modern Microprocessors. 4 Units.
Fundamental concepts and recent advances in computer architecture necessary to understand and use modern microprocessors. Topics span out-of-order execution, multiple instruction issue, control/data speculation, predication, advanced cache and DRAM organizations, embedded systems, DSP and multi-media instructions.

Prerequisite: COMPSCI 250A.

Overlaps with COMPSCI 243.

COMPSCI 252. Introduction to Computer Design. 4 Units.
The methodology and use of CAD tools for computer design, accomplished by a lab in which students practice design using commercially available silicon compilers and other tools.

Prerequisite: COMPSCI 151 and COMPSCI 152.

COMPSCI 253. Analysis of Programming Languages. 4 Units.
Concepts in modern programming languages, their interaction, and the relationship between programming languages and methods for large-scale, extensible software development. Empirical analysis of programming language usage.

Same as IN4MATX 212.

COMPSCI 259S. Seminar in Design Science. 2 Units.
Current research and research trends in design science. Forum for presentation and criticism by students of research work in progress.

Repeatability: May be taken for credit 18 times.
COMPSCI 260. Fundamentals of the Design and Analysis of Algorithms. 4 Units.
Covers fundamental concepts in the design and analysis of algorithms and is geared toward non-specialists in theoretical computer science. Topics include: deterministic and randomized graph algorithms, fundamental algorithmic techniques like divide-and-conquer strategies and dynamic programming, and NP-completeness.
Prerequisite: COMPSCI 161.

COMPSCI 261. Data Structures. 4 Units.
An in-depth treatment of data structures and their associated management algorithms including resource complexity analysis.
Prerequisite: I&C SCI 46 and COMPSCI 161.

COMPSCI 262. Computational Complexity. 4 Units.
Advanced course in computational models and complexity classes. Covers the fundamentals of Turing Machines, Decidability, and NP-completeness. Includes discussion of more advanced topics including polynomial hierarchy, randomized complexity classes, #P-completeness and hardness of approximation.
Prerequisite: COMPSCI 162.

COMPSCI 263. Analysis of Algorithms. 4 Units.
Analysis of correctness and complexity of various efficient algorithms; discussion of problems for which no efficient solutions are known.
Prerequisite: COMPSCI 161 and COMPSCI 261.

COMPSCI 264. Quantum Computation and Information. 4 Units.
Basic models for quantum computation and their foundations in quantum mechanics. Quantum complexity classes and quantum algorithms including algorithms for factoring and quantum simulation. Introduction to quantum information theory and quantum entanglement.
Prerequisite: Basic courses in linear algebra and algorithms.

COMPSCI 265. Graph Algorithms. 4 Units.
Graph definitions, representation methods, graph problems, algorithms, approximation methods, and applications.
Prerequisite: COMPSCI 161 and COMPSCI 261.

COMPSCI 266. Computational Geometry. 4 Units.
An overview of some of the basic problems in computational geometry and of some algorithmic and data-structuring techniques appropriate to their solution.
Prerequisite: COMPSCI 161 and COMPSCI 261.

COMPSCI 267. Data Compression. 4 Units.
An introduction to the theory and practice of modern data compression techniques. Topics include codes, coding, modeling, text compression, lossless and lossy image compression standards and systems, audio compression.
Prerequisite: (COMPSCI 261 and COMPSCI 260) or COMPSCI 261.

COMPSCI 268. Introduction to Optimization. 4 Units.
Prerequisite: STATS 67 and (I&C SCI 6N or MATH 3A or MATH 6G).
Concurrent with COMPSCI 169.

COMPSCI 269S. Seminar in the Theory of Algorithms and Data Structures. 2 Units.
Current research and research trends in the Theory of algorithms and data structures.
Repeatability: May be taken for credit 18 times.

COMPSCI 271. Introduction to Artificial Intelligence. 4 Units.
The study of theories and computational models for systems which behave and act in an intelligent manner. Fundamental subdisciplines of artificial intelligence including knowledge representation, search, deduction, planning, probabilistic reasoning, natural language parsing and comprehension, knowledge-based systems, and learning.
COMPSCI 273A. Machine Learning. 4 Units.
Computational approaches to learning algorithms for classifications, regression, and clustering. Emphasis is on discriminative classification methods such as decision trees, rules, nearest neighbor, linear models, and naive Bayes.
Prerequisite: COMPSCI 271 and COMPSCI 206.

COMPSCI 274A. Probablistic Learning: Theory and Algorithms. 4 Units.
An introduction to probabilistic and statistical techniques for learning from data, including parameter estimation, density estimation, regression, classification, and mixture modeling.
Prerequisite: COMPSCI 206.

COMPSCI 274B. Learning in Graphical Models. 4 Units.
Models for data analysis are presented in the unifying framework of graphical models. The emphasis is on learning from data but inference is also covered. Real world examples are used to illustrate the material.
Prerequisite: COMPSCI 274A.

COMPSCI 274C. Neural Networks and Deep Learning. 4 Units.
Neural network and deep learning from multiple perspectives. Theory of parallel distributed processing systems, algorithmic approaches for learning from data in various manners, applications to difficult problems in AI from computer vision, to natural language understanding, to bioinformatics and chemoinformatics.
Prerequisite: STATS 120A and STATS 120B, or MATH 121A or COMPSCI 178 or COMPSCI 273A, or equivalents.
Overlaps with COMPSCI 274A, COMPSCI 279S, COMPSCI 277, COMPSCI 276, COMPSCI 278, COMPSCI 274B.
Concurrent with COMPSCI 172B.

COMPSCI 275. Network-based Reasoning/Constraint Networks. 4 Units.
Study of the theory and techniques of constraint network model. Covers techniques for solving constraint satisfaction problems: backtracking techniques, consistency algorithms, and structure-based techniques. Tractable subclasses. Extensions into applications such as temporal reasoning, diagnosis, and scheduling.
Prerequisite: Basic course in algorithm design and analysis.

COMPSCI 276. Network-based reasoning/Belief Networks. 4 Units.
Focuses on reasoning with uncertainty using "Bayes Networks" that encode knowledge as probabilistic relations between variables, and the main task is, given some observations, to update the degree of belief in each proposition.
Prerequisite: A basic course in probability.

COMPSCI 277. Data Mining. 4 Units.
Introduction to the general principles of inferring useful knowledge from large data sets (commonly known as data mining or knowledge discovery). Relevant concepts from statistics, databases and data structures, optimization, artificial intelligence, and visualization are discussed in an integrated manner.
Prerequisite: COMPSCI 273A or COMPSCI 274A.

COMPSCI 278. Probability Models. 4 Units.
Advanced probability, discrete time Markov chains, Poisson processes, continuous time Markov chains. Queuing or simulation as time permits.
Prerequisite: STATS 120A.
Concurrent with STATS 121.

COMPSCI 279S. Seminar in Artificial Intelligence. 2 Units.
Current research and research trends in artificial intelligence.
Repeatability: May be taken for credit 18 times.
COMPSCI 284A. Representations and Algorithms for Molecular Biology. 4 Units.
Introduction to computational methods in molecular biology, aimed at those interested in learning about this interdisciplinary area. Covers computational approaches to understanding and predicting the structure, function, interactions, and evolution of DNA, RNA, proteins, and related molecules and processes.

Prerequisite: A Basic course in algorithms, or a basic course in molecular biology.

 Concurrent with COMPSCI 184A.

COMPSCI 284B. Probabilistic Modeling of Biological Data. 4 Units.
A unified Bayesian probabilistic framework for modeling and mining biological data. Applications range from sequence (DNA, RNA, proteins) to gene expression data. Graphical models, Markov models, stochastic grammars, structure prediction, gene finding, evolution, DNA arrays, single- and multiple-gene analysis.

Prerequisite: COMPSCI 284A.

 Concurrent with COMPSCI 184B.

COMPSCI 284C. Computational Systems Biology. 4 Units.

Prerequisite: COMPSCI 284A or COMPSCI 284B or (BIO SCI 99 and MATH 2D and MATH 2J).

 Concurrent with COMPSCI 184C.

COMPSCI 285. Mathematical and Computational Biology . 4 Units.

Prerequisite: MATH 227A.

 Same as MATH 227C.

COMPSCI 288A. Biological Networks. 4 Units.
Introduces the basics of primarily graph theoretic analysis and modeling of biological networks. Presents the necessary biological background for understanding different types of biological networks as well as mathematical, algorithmic, and computational complexity issues associated with them.

Prerequisite: I&C SCI 6D and (COMPSCI 161 or CSE 161) and BIO SCI M123.

COMPSCI 289S. Seminar for Informatics in Biology and Medicine. 2 Units.
Current research and research trends in bioinformatics and medical informatics. Forum for presentation and criticism by students of recently published research and work in progress.

Prerequisite: COMPSCI 284A or COMPSCI 284B.

Repeatability: May be repeated for credit unlimited times.

COMPSCI 290. Research Seminar. 2 Units.
Forum for presentation and criticism by students of research work in progress. Presentation of problem areas and related work. Specific goals and progress of research.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

COMPSCI 295. Special Topics in Information and Computer Science . 4 Units.
Studies in selected areas of Information and Computer Science. Topics addressed vary each quarter.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.
COMPSCI 296. Elements of Scientific Writing. 4 Units.
Introduces the concepts and principles of good scientific writing, demonstrates them by examples drawn from the literature, and uses a hands-on approach to apply them to documents being written by the participants.

Grading Option: Satisfactory/unsatisfactory only.

COMPSCI 298. Thesis Supervision. 2-12 Units.
Individual research or investigation conducted in preparation for the M.S. thesis option or the dissertation requirements for the Ph.D. program.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only. School of Information and Computer Science majors only.

COMPSCI 299. Individual Study. 1-12 Units.
Individual research or investigation with Computer Science faculty.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only. School of Information and Computer Science majors only.