CSCE 601 Programming with C and Java
Credits 3. 3 Lecture Hours.
Survey of the C and Java programming languages, including principles of procedural and object-oriented languages; multi-disciplinary applications including business, Internet and engineering problems.
Prerequisite: Graduate classification.

CSCE 602 Object-Oriented Programming, Development and Software Engineering
Credits 3. 3 Lecture Hours.
Teaches Object-Oriented Programming in C++; software engineering techniques presented to teach how to build high quality software; semester project gives quasi-real-world experience with issues such as requirements capture and object-orient development.
Prerequisites: CSCE 601 or approval of instructor; graduate classification.

CSCE 603 Database Systems and Applications
Credits 3. 3 Lecture Hours.
Introduction to the concepts and design methodologies of database systems for non-computer science majors; emphasis on E. F. Codd's relational model with hands-on design application. No credit will be given for both CSCE 310 and CSCE 603.
Prerequisites: CSCE 601; graduate classification.

CSCE 604 Programming Languages
Credits 3. 3 Lecture Hours.
Study in the design space of programming languages, covering language processing, formalisms to describe semantics of programming languages, important concepts found in current programming languages, and programming paradigms.
Prerequisite: Graduate classification.

CSCE 605 Compiler Design
Credits 3. 3 Lecture Hours.
Advanced topics in compiler writing; parser generators and compiler-compilers; dynamic storage and scope resolution; data flow analysis and code optimization.
Prerequisite: CSCE 434.

CSCE 606 Software Engineering
Credits 3. 3 Lecture Hours.
Development of advanced concepts in software engineering; software development environments as a mechanism for enhancing productivity and software quality; the classification, evaluation and selection of methodologies for environments; rapid prototyping and reusability concepts; artificial intelligence techniques applied to software engineering.
Prerequisite: CSCE 431 or approval of instructor.

CSCE 608 Database Systems
Credits 3. 3 Lecture Hours.
Database modeling techniques; expressiveness in query languages including knowledge representation; manipulation languages data models; physical data organization; relational database design theory; query processing; transaction management and recovery; distributed data management.
Prerequisite: CSCE 310 or CSCE 603.

CSCE 610 Hypertext/Hypermedia Systems
Credits 3. 3 Lecture Hours.
Comprehensive coverage of Hypertext/Hypermedia; basic concepts and definitions; fundamental components, architectures and models; problems and current solutions; design and implementation issues; and research issues.
Prerequisites: CSCE 310 or CSCE 603; CSCE 313.

CSCE 611 Operating Systems and Applications
Credits 3. 3 Lecture Hours.
Review of computer architecture hardware/software evolution leading to contemporary operating systems; basic operating systems concepts; methods of operating systems design and construction; algorithms for CPU scheduling memory and general resource allocation; process coordination and management; case studies of several operating systems; quality-of-services of operating systems and their impact on applications. No credit will be given for both CSCE 410 and CSCE 611.
Prerequisites: CSCE 313; graduate classification.

CSCE 612 Applied Networks and Distributed Processing
Credits 3. 3 Lecture Hours.
Fundamentals, including network design and protocol analysis, in the context of computer communications; mixes fundamentals with both programming and pragmatic views of engineering issues; it includes network architecture as well as principles of network engineering; focus is on applying principles of layered architecture to analyzing real networks; lab exercises focus on protocol understanding and programming; knowledge of UNIX and C programming helpful, but not required. No credit will be given for both CSCE 463 and CSCE 612.
Prerequisite: Graduate classification.

CSCE 613 Operating Systems
Credits 3. 3 Lecture Hours.
Analysis of algorithms in computer operating systems; sequencing and control algorithms supporting concurrent processes; scheduling algorithms to minimize execution times and mean flow times; algorithms for allocating tasks to processors; allocation of memory (virtual and real); direct access device schedules; auxiliary and buffer storage models.
Prerequisite: CSCE 313 or CSCE 611.

CSCE 614 Computer Architecture
Credits 3. 3 Lecture Hours.
Reviews of von Neumann architecture and its limitations; parallel computer structures and concurrent computation; pipeline computers and vectorization methods; array processors, multiprocessor architectures and programming; dataflow computers.
Prerequisite: CSCE 350/ECEN 350/ECEN 350/CSCE 350.

CSCE 616 Introduction to Hardware Design Verification
Credits 3. 3 Lecture Hours.
Introduction to hardware functional verification; case studies on verification in integrated circuit design; introduction to industry best practices; introduction to logic functional verification.
Prerequisites: CSCE 312 or CSCE 350/ECEN 350, or equivalent in computer architecture; familiarity with C/C++/Verilog/VHDL programming.
CSCE 617 Co-Design of Embedded Systems (CODES)
Credits 3.3 Lecture Hours.
Co-design methodologies of hardware-software systems; models of computation (MOC), system specification, co-simulation, synthesis, and verification; hardware-software implementation; core-based systems and interfaces, performance analysis and optimization; system on chip, power aware design.
Prerequisites: CSCE 462 or equivalent, CSCE 410 and graduate classification.

CSCE 619 Networks and Distributed Computing
Credits 3.3 Lecture Hours.
Computer network concepts including network architecture, layering, protocols, packet switching and virtual circuits; performance evaluation and design considerations for local area networks; packet distributed networks; satellite networks.
Prerequisite: CSCE 463 or CSCE 612.

CSCE 620/VIZA 670 Computational Geometry
Credits 3.3 Lecture Hours.
Design and analysis of algorithms for solving geometrical problems; includes convex hull problems, Voronoi diagrams, range searching and proximity problems.
Prerequisite: CSCE 311.
Cross Listing: VIZA 670/CSCE 620.

CSCE 621 Language, Library, and Program Design Using C++
Credits 3.3 Lecture Hours.
Exploration of the interactions among language design, library design, and program design in the context of ISO standard C++ and its proposed extensions; Novel features provided by C++ and the design and programming techniques supported.
Prerequisites: Graduate classification or approval of instructor; understanding of C++ and experience with software development projects helpful; knowledge of at least one programming language in addition to C and C++.

CSCE 622 Generic Programming
Credits 3.3 Lecture Hours.
The generic programming approach to design and systematic classification of software components, techniques for achieving correctness, efficiency, and generality of algorithms, data structures, and memory management, methods of structuring a library of generic software components for maximum usability are practiced in a significant design and implementation project.
Prerequisite: CSCE 221.

CSCE 624 Sketch Recognition
Credits 3.3 Lecture Hours.
Analysis, implementation, and comparison of sketch recognition algorithms, including feature-based, vision-based, geometrical, timing-based, and path-based recognition algorithms. Methods for combining these recognition methods for greater accuracy, using known AI techniques, are also examined.
Prerequisite: Graduate classification.

CSCE 625 Artificial Intelligence
Credits 3.3 Lecture Hours.
Basic concepts and methods of artificial intelligence; Heuristic search procedures for general graphs; game playing strategies; resolution and rule based deduction systems; knowledge representation; reasoning with uncertainty.
Prerequisite: CSCE 221.

CSCE 626 Parallel Algorithm Design and Analysis
Credits 3.3 Lecture Hours.
Design of algorithms for use on highly parallel machines; area-time complexity of problems and general lower bound theory; application of these concepts to artificial intelligence, computer vision and VLSI design automation.
Prerequisite: CSCE 221.

CSCE 627 Theory of Computability
Credits 3.3 Lecture Hours.
Formal models of computation such as pushdown automata; Turing machines and recursive functions; unsolvability results; complexity of solvable results.
Prerequisite: CSCE 433.

CSCE 628/BICH 628 Computational Biology
Credits 3.3 Lecture Hours.
Introduction to computational biology; formulations of biology problems as computational problems; computational approaches to solve problems in genomics and proteomics.
Prerequisite: Graduate classification or approval of instructor.
Cross Listing: BICH 628/CSCE 628.

CSCE 629 Analysis of Algorithms
Credits 3.3 Lecture Hours.
Concrete algorithm design and analysis; abstract models to analyze the complexity of problems; NP-Completeness; approximation and probabilistic algorithms.
Prerequisite: CSCE 411.

CSCE 630 Speech Processing
Credits 3.3 Lecture Hours.
Speech production and perception (speech apparatus, articulatory/auditory phonetics); mathematical foundations (sampling, filtering, probability, pattern recognition); speech analysis and coding (short-time Fourier analysis, linear prediction, cepstrum); speech recognition (dynamic time warping, hidden Markov models, language models); speech synthesis (front-end, back-end); speech modification (overlap-add, enhancement, voice conversion).
Prerequisites: ECEN 314 or equivalent or approval of instructor. Basic knowledge of signals and systems, linear algebra, probability and statistics. Programming experience in a high-level language is required.

CSCE 631 Intelligent Agents
Credits 3.3 Lecture Hours.
On the design and implementation of Intelligent Agents and coordination mechanisms among multiple agents, ranging from theoretical principles to practical methods for implementation.
Prerequisite: CSCE 420 or CSCE 625.

CSCE 633 Machine Learning
Credits 3.3 Lecture Hours.
Machine learning is the study of self-modifying computer systems that can acquire new knowledge and improve their own performance; survey machine learning techniques, which include induction from examples, conceptual clustering, explanation-based learning, exemplar learning and analogy, discovery and genetic algorithms.
Prerequisite: CSCE 420 or CSCE 625.

CSCE 634 Intelligent User Interfaces
Credits 3.3 Lecture Hours.
Intersection of artificial intelligence and computer-human interaction: emphasis on designing and evaluating systems that learn about and adapt to their users, tasks, and environments.
Prerequisites: Graduate classification and approval of instructor.
CSCE 635 AI Robotics
Credits 3. 3 Lecture Hours. 1 Lab Hour.
Introduction and survey of artificial intelligence methods for mobile robots (ground, aerial, or marine) for science and engineering majors; theory and practice of unmanned systems, focusing on biological and cognitive principles which differ from control theory formulations.

CSCE 636 Neural Networks
Credits 3. 3 Lecture Hours.
Basic concepts in neural computing; functional equivalence and convergence properties of neural network models; associative memory models; associative, competitive and adaptive resonance models of adaptation and learning; selective applications of neural networks to vision, speech, motor control and planning; neural network modeling environments.
Prerequisites: MATH 304 and MATH 308 or approval of instructor.

CSCE 637 Complexity Theory
Credits 3. 3 Lecture Hours.
Deterministic, non-deterministic, alternating and probabilistic computations; reducibilities; P, NP and other complexity classes; abstract complexity; time, space and parallel complexity; and relativized computation.
Prerequisite: CSCE 627 or approval of instructor.

CSCE 638 Natural Language Processing: Foundations and Techniques
Credits 3. 3 Lecture Hours.
Focus on teaching Natural Language Processing (NLP) fundamentals including language models, automatic syntactic processing and semantic understanding; introduction to major NLP applications including information extraction, machine translation, text summarization, dialogue systems and sentiment analysis.
Prerequisite: CSCE 221.

CSCE 639/MEE 676 Fuzzy Logic and Intelligent Systems
Credits 3. 3 Lecture Hours.
Introduces the basics of fuzzy logic and its role in developing intelligent systems; topics include fuzzy set theory, fuzzy rule inference, fuzzy logic in control, fuzzy pattern recognition, neural fuzzy systems and fuzzy model identification using genetic algorithms.
Prerequisite: CSCE 625 or approval of instructor.
Cross Listing: MEEN 676/CSCE 639.

CSCE 640 Quantum Algorithms
Credits 3. 3 Lecture Hours.
Introduction to the design and analysis of quantum algorithms; basic principles of the quantum circuit model; gives a gentle introduction to basic quantum algorithms; reviews recent results in quantum information processing.
Prerequisite: CSCE 629 or approval of instructor.

CSCE 641/VIZA 672 Computer Graphics
Credits 3. 3 Lecture Hours.
Representations of 3-dimensional objects, including polyhedral objects, curved surfaces, volumetric representations and CSG models; techniques for hidden surface/edge removal and volume rendering; illumination and shading; anti-aliasing; ray tracing; radiosity; animation; practical experience with state-of-the-art graphics hardware and software.
Prerequisite: CSCE 441.
Cross Listing: VIZA 672/CSCE 641.

CSCE 643 Seminar in Intelligent Systems and Robotics
Credits 3. 3 Lecture Hours.
Problems, methods and recent developments in intelligent systems and robotics. May be taken at multiple times for credit as content varies.
Prerequisite: Approval of instructor.

CSCE 644 Cortical Networks
Credits 3. 3 Lecture Hours.
The architecture of the mammalian cerebral cortex; its modular organization and its network for distributed and parallel processing; cortical networks in perception and memory; neuronal microstructure and dynamical simulation of cortical networks; the cortical network as a proven paradigm for the design of cognitive machines.
Prerequisites: CSCE 420 or CSCE 625 and CSCE 636 and graduate classification.

CSCE 645/VIZA 675 Geometric Modeling
Credits 3. 3 Lecture Hours.
Geometric and solid modeling concepts. Freeform curves and surfaces (splines and Bezier) with their relational, intersectional and global mathematical properties. Parametric representation of solids, topology of closed curved surfaces, boundary concepts and Boolean/Euler operators. Construction and display of curves and surfaces, and solid models.
Prerequisites: CSCE 441 and CSCE 442 or equivalent.
Cross Listing: VIZA 675/CSCE 645.

CSCE 646/VIZA 654 The Digital Image
Credits 4. 3 Lecture Hours. 2 Lab Hours.
Tools and techniques for generation, handling and analysis of two dimensional digital images; image representation and storage; display, media conversion, painting and drawing; warping; color space operations, enhancement, filtering and manipulation.
Prerequisite: Graduate classification or approval of instructor.
Cross Listing: VIZA 654/CSCE 646.

CSCE 647/VIZA 656 Image Synthesis
Credits 4. 3 Lecture Hours. 2 Lab Hours.
Principles of image synthesis from 3-D scene descriptions; includes local and global illumination, shading, shadow determination, hidden surface elimination, texturing, raster graphics algorithms, transformations and projects.
Prerequisite: Approval of instructor.
Cross Listing: VIZA 656/CSCE 647.

CSCE 648/VIZA 675 Computer Aided Sculpting
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Mathematical and artistic principles of 3-D modeling and sculpting; includes proportions, skeletal foundation, expression and posture, line of action; curves, surfaces and volumes, interpolation and approximation, parametric and rational parametric polynomials, constructive solid geometry, and implicit representations.
Prerequisite: Approval of instructor.
Cross Listing: VIZA 657/CSCE 648.

CSCE 649/VIZA 659 Physically-Based Modeling
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Physical simulation as used in choreography, geometric modeling, and the creation of special effects in computer graphics: a variety of problems and techniques explored which may include particle-methods, modeling and simulation of flexible materials, kinematics and constraint systems.
Prerequisite: Approval of instructor.
Cross Listing: VIZA 659/CSCE 649.
CSCE 652 Software Reverse Engineering  
**Credits 3. 2 Lecture Hours. 2 Lab Hours.**  
Introduction to the compilation mechanism to generate executable files and raw binary codes from sources codes; the executable file formats for an operation system to run the binary code; disassembly algorithms and control graph analysis; static and dynamic analyses; case studies on code obfuscation, codebreaking and malware analysis.  
**Prerequisites:** CSCE 313 or approval of instructor.

CSCE 653 Computer Methods in Applied Sciences  
**Credits 3. 3 Lecture Hours.**  
Classical and modern techniques for the computational solution of problems of the type that traditionally arise in the natural sciences and engineering; introductions to number representation and errors, locating roots of equations, interpolation, numerical integration, linear algebraic systems, spline approximations, initial-value problems for ordinary differential equations and finite-difference methods for partial differential equations.  
**Prerequisite:** CSCE 442 or MATH 417; graduate classification.

CSCE 654 Supercomputing  
**Credits 3. 3 Lecture Hours.**  
Principles of high-performance scientific computing systems, vectorization, programming on supercomputers, numerical methods for supercomputers, performance measuring of supercomputers, multitasking.  
**Prerequisite:** CSCE 614.

CSCE 655 Human-Centered Computing  
**Credits 3. 3 Lecture Hours.**  
A foundation course in human centered systems and information; understanding and conceptualizing interaction; design and prototyping methodologies; evaluation frameworks; visual design using color, space, layering, and media; information structuring and visualization; animation and games; individual and team programming projects.  
**Prerequisite:** Graduate classification or CSCE 436 or 444 or approval of instructor.

CSCE 656 Computers and New Media  
**Credits 3. 3 Lecture Hours.**  
This class investigates the potential and realized impact of computers in the design of new media, explores the variety of relationships between authors and readers of interactive materials, and explores the influence of media design and content expressed.  
**Prerequisite:** Graduate classification.

CSCE 657/PETE 657 High Performance Computing for Earth Science and Petroleum Engineering  
**Credits 3. 3 Lecture Hours.**  
Numerical simulation of problems in Earth Sciences and Petroleum Engineering using high performance computing (HPC); development of a parallel reservoir simulator.  
**Prerequisite:** Graduate classification.  
**Cross Listing:** PETE 657/CSCE 657.

CSCE 658 Randomized Algorithms.  
**Credits 3. 3 Lecture Hours.**  
Introduction to randomized algorithms; selected tools and techniques from probability theory and game theory are reviewed, with a view towards algorithmic applications; the main focus is a thorough discussion of the main paradigms, techniques, and tools in the design and analysis of randomized algorithms; a detailed analysis of numerous algorithms illustrates the abstract concepts and techniques.  
**Prerequisite:** Graduate classification.

CSCE 659/ECEN 659 Parallel/Distributed Numerical Algorithms and Applications  
**Credits 3. 3 Lecture Hours.**  
A unified treatment of parallel and distributed numerical algorithms; parallel and distributed computation models, parallel computation of arithmetic expressions; fast algorithms for numerical linear algebra, partial differential equations and nonlinear optimization.  
**Prerequisites:** CSCE 653; MATH 304.  
**Cross Listing:** ECEN 659/CSCE 659.

CSCE 660/MATH 660 Computational Linear Algebra  
**Credits 3. 3 Lecture Hours.**  
Techniques in matrix computation: elimination methods, matrix decomposition, generalized inverses, orthogonalization and least-squares, eigenvalue problems and singular value decomposition, iterative methods and error analysis.  
**Prerequisite:** CSCE 442 or equivalent or MATH 417 or equivalent.  
**Cross Listing:** MATH 660/CSCE 660.

CSCE 661 Integrated Systems Design Automation  
**Credits 3. 3 Lecture Hours.**  
VLSI design systems and their levels of abstracting; algorithms for general VLSI design and implementation; computer aided design tools and principles; physical and logical models.  
**Prerequisite:** Graduate classification.

CSCE 662 Distributed Processing Systems  
**Credits 3. 3 Lecture Hours.**  
Principles and practices of distributed processing; protocols, remote procedure calls; file sharing; reliable system design; load balancing; distributed database systems; protection and security; implementation.  
**Prerequisite:** CSCE 313 and CSCE 463 or CSCE 612.

CSCE 663 Real-Time Systems  
**Credits 3. 3 Lecture Hours.**  
Taxonomy of real-time computer systems; scheduling algorithms for static and dynamic real-time tasks; hard real-time communications protocols; programming languages and environments for real-time systems; case studies of real-time operating systems.  
**Prerequisites:** CSCE 313, and CSCE 463 or CSCE 611, or approval of instructor.

CSCE 664 Wireless and Mobile Systems  
**Credits 3. 3 Lecture Hours.**  
Wireless and mobile systems; wireless communication fundamentals; wireless medium access control design; transmission scheduling; network and transport protocols over wireless design, simulation and evaluation; wireless capacity; telecommunication systems; vehicular, adhoc, and sensor network systems; wireless security; mobile applications.  
**Prerequisite:** CSCE 463 or CSCE 464 or approval of instructor.

CSCE 665 Advanced Networking and Security  
**Credits 3. 3 Lecture Hours.**  
Security aspects of various network protocols including investigation and tool development using "live" machines and networks.  
**Prerequisites:** Graduate classification and approval of instructor.
CSCE 666 Pattern Analysis
Credits 3. 3 Lecture Hours.
Introduction to methods for the analysis, classification and clustering of high dimensional data in Computer Science applications. Course contents include density and parameter estimation, linear feature extraction, feature subset selection, clustering, Bayesian and geometric classifiers, non-linear dimensionality reduction methods from statistical learning theory and spectral graph theory, Hidden Markov models, and ensemble learning.
Prerequisites: MATH 222, MATH 411 (or equivalent) and graduate classification.

CSCE 667 Seminar in Human-Centered Computing
Credits 3. 3 Lecture Hours.
Problems, methods and recent developments in human-centered computing and information. May be repeated for credit as content varies.
Prerequisites: Graduate classification.

CSCE 668 Distributed Algorithms and Systems
Credits 3. 3 Lecture Hours.
Introduction to fundamental algorithmic results in distributed computing systems; leader election, mutual exclusion, consensus, logical time and causality, distributed snapshots, algorithmic fault tolerance, shared memory, clock synchronization.
Prerequisites: CSCE 411 or equivalent or approval of instructor.

CSCE 669 Computational Optimization
Credits 3. 3 Lecture Hours.
Combinatorial theory of polytopes as a tool for the solution of combinatorial optimization problems; applications to max flow, matching and matroids; geometric interpretation of the results indicating the profound role that polyhedral combinatorics play in the design and complexity of approximation algorithms.
Prerequisite: CSCE 629.

CSCE 670 Information Storage and Retrieval
Credits 3. 3 Lecture Hours.
Representation, storage, and access to very large multimedia document collections; fundamental data structures and algorithms of information storage and retrieval systems; techniques to design and evaluate complete retrieval systems, including cover of algorithms for indexing, compressing, and querying very large collections.
Prerequisites: CSCE 310 or CSCE 603 or approval of instructor; graduate classification.

CSCE 671 Computer-Human Interaction
Credits 3. 3 Lecture Hours.
Comprehensive coverage of Computer-human Interaction (CHI) including history, importance, design theories and future direction; modeling computer users and interfaces, empirical techniques for task analysis and interface design, and styles of interaction.
Prerequisite: Graduate classification.

CSCE 672 Computer Supported Collaborative Work
Credits 3. 3 Lecture Hours.
Covers design, implementation and use of technical systems that support people working cooperatively; draws from the research area of Computer Supported Cooperative Work (CSCW) and includes current theoretical, practical, technical and social issues in CSCW and future directions of the field.
Prerequisite: CSCE 671 or CSCE 610 or approval of instructor.

CSCE 675 Digital Libraries
Credits 3. 3 Lecture Hours.
Surveys current research and practice in Digital Libraries, which seek to provide intellectual access to large-scale, distributed digital information repositories; current readings from the research literature which covers the breadth of this interdisciplinary area of study.
Prerequisite: Graduate classification in computer science.

CSCE 680/ECEN 680 Testing and Diagnosis of Digital Systems
Credits 3. 3 Lecture Hours.
The theory and techniques of testing VLSI-based circuits and systems, and design for testability.
Prerequisites: CSCE 321 or ECEN 350/CSCE 350 or equivalent; ECEN 220 or ECEN 248 or equivalent.
Cross Listing: ECEN 680/CSCE 680.

CSCE 681 Seminar
Credit 1. 1 Lecture Hour.
Reports and discussion of current research and of selected published technical articles. May not be taken for credit more than once in master's degree program nor twice in PhD program.

CSCE 684 Professional Internship
Credits 1 to 16. 1 to 16 Other Hours.
Training under the supervision of practicing computer professionals in settings appropriate to the student's professional objectives, away from the Texas A&M University campus.
Prerequisites: Approval of department head and one semester of graduate work completed.

CSCE 685 Directed Studies
Credits 1 to 12. 1 to 12 Other Hours.
Research problems of limited scope designed primarily to develop research technique.

CSCE 689 Special Topics in...
Credits 1 to 4. 1 to 4 Lecture Hours. 0 to 4 Lab Hours.
Selected topics in an identified area of computer science. May be repeated for credit.
Prerequisite: Approval of instructor.

CSCE 691 Research
Credits 1 to 23. 1 to 23 Other Hours.
Research for thesis or dissertation.