Computer Science (CS)

CS 1030 Foundations of Computer Science 3:3:0 Fall, Spring, Summer
Introduces the basics of computing, including computer hardware, and programming concepts and language. Explores how computers work and how a computer may be programmed. Includes a brief history of computer programming languages, and computer numbering systems. Presents basic programming constructs; students produce a variety of introductory level programs. Surveys various computing professions. May be delivered hybrid and/or online. Lab access fee of $35 applies.

CS 1400 Fundamentals of Programming 3:3:0 Fall, Spring, Summer
* Prerequisite(s): CS 1400
For Majors in Computer Science, Computer Engineering, Software Engineering, and other majors requiring computer programming skills. Introduces the fundamental concepts of computer programming. Presents the ideas, tools, structure, syntax, and design techniques for developing well-formed programs. Studies problem solving, program structure, data types, decision logic, loops, functions, input and output, and arrays. Introduces the basic ideas of classes and objects. Requires students to program a number of assignments that demonstrate their understanding of these concepts. May be delivered online. Lab access fee of $35 for computers applies. Canvas Course Mats $66/Cengage applies.

CS 1410 Object Oriented Programming 3:3:0 Fall, Spring, Summer
* Prerequisite(s): CS 1400
Introduces the key concepts of object-oriented programming. Includes pointers and dynamic memory allocation, linked lists, inheritance and polymorphism, the development of graphical user interfaces, operator overloading, memory management, exceptions, templates and the standard template library, and an overview of object-oriented analysis and design. May be delivered online. Lab access fee of $35 for computers applies.

CS 2250 Java Programming 3:3:0
* Prerequisite(s): CS 1400
Covers practical Java programming in-depth, including abstract classes and interfaces, proper use of the packages Java.lang, Java.io, and Java.util, GUI design and implementation, and programming. Lab access fee of $35 for computers applies.

CS 2300 Discrete Mathematical Structures I 3:3:0 Fall, Spring, Summer
* Prerequisite(s): CS 1410 and (MATH 1050 or higher)
For Computer Science Majors. Covers algebraic structures applied to computer programming. Includes logic, sets, elementary number theory, mathematical induction, recursion, algorithm complexity, combinators, and relations. First of a two-semester sequence. Lab access fee of $35 for computers applies.

CS 2370 C plus plus Programming 3:3:0
* Prerequisite(s): CS 1400
Covers practical C++ programming in-depth, including advanced operator overloading and memory management, proper use of exceptions, defensive programming techniques, automated testing, multiple inheritance, advanced memory management, proper use of the standard template library, and programming. Lab access fee of $35 for computers applies.

CS 2420 Introduction to Algorithms and Data Structures 3:3:0 Fall, Spring, Summer
* Prerequisite(s): CS 1410
Introduces data structures using an object-oriented programming language, and paradigm. Studies data abstraction as a design tool. Includes advanced arrays, records, dynamic data structures, searching and sorting, vectors, trees, linked lists, and graphs. Uses file I/O to store data structures. Discusses algorithm metrics. Lab access fee of $35 for computers applies. Canvas Course Mats $66/Cengage applies.

CS 2450 Software Engineering 3:3:0 Fall, Spring, Summer
* Prerequisite(s): CS 2300, CS 2420
Presents concepts, methodology and best-practices necessary to develop large scale software projects. Includes step-wise software requirements analysis, design, implementation, testing and release. Discusses software generation, reuse, scheduling, verification, and maintenance. Emphasizes current "real world" industry best-practices and tools. Lab access fee of $35 for computers applies.

CS 2550 Web Programming I 3:3:0 Fall, Spring
* Prerequisite(s): CS 1410 or DGM 2760 or INFO 1200
Covers design and development of browser-based programs with an emphasis on single-page applications. Teaches generation and modification of HTML via JavaScript, debugging techniques, communicating with web servers, and use of XML and JSON. Lab access fee of $35 for computers applies.

CS 2600 Computer Networks I 3:3:0 Fall, Spring
* Prerequisite(s): CS 2810 or (INFO 1200 and IT 1600)
A rigorous introduction to computer networking theory and technologies for Computer Science and Information Technology majors. Includes theory of data communications protocols; theory and design of transmission systems; transmission media; and communication software. Emphasizes the lower layers of the Open Systems Interconnection model. Requires lab exercises to be completed outside of lecture. Lab access fee of $35 for computers applies.

CS 2690 Computer Networks II 3:3:0 Fall, Spring
* Prerequisite(s): CS 1410, CS 2300, CS 2600
* Prerequisite(s) or Corequisite(s): MATH 1210
Continues CS 2600 Computer Networks I. Focuses on the upper layers of the OSI and Internet models. Covers Internet (TCP/IP) protocols, routing theory, transport protocols, network application interfaces, presentation formatting, information theory and compression, cryptography, and other emerging technologies as time permits. Requires lab exercises and programming assignments to be completed outside of lecture. Software fee of $15 applies. Lab access fee of $35 for computers applies.

CS 2810 Computer Organization and Architecture 3:3:0 Fall, Spring, Summer
* Prerequisite(s): CS 1400
Uses assembly language to introduce basic concepts of computer organization. Includes number systems, CPU organization, instruction sets, programming in assembly, memory organization, debugging, program design, and documentation. Covers interrupts, vector tables, and disk I/O. Lab access fee of $35 for computers applies.

CS 281R Internship 1 to 8:1 to 8:0 Fall, Spring, Summer
* Prerequisite(s): Department approval
Provides on-the-job work experience for CNS majors. Utilizes the skills and abilities in the fields of computer science, software engineering, networking, and/or computer engineering. May be repeated for a maximum of three credits toward graduation. May be graded credit/no credit.

Utah Valley University Course Catalog 2019-2020 1
CS 291R
Independent Study
1 to 6:00 to 6:00 to 18 Not Offered
This course will allow the student to pursue an independent topic in computer science and study this topic in-depth in a flexible non-classroom environment. A maximum of three hours may be counted towards graduation without prior written CNS Department approval. The topic must be approved by the instructor and the CNS Department Chair. Lab access fee of $35 for computers applies.

CS 296R
CS Seminar
1 to 3:0 to 3:0 to 12 Not Offered
Presents topics of current interest to computer science in a seminar environment. Includes invited lectures by experts in the field, or a review of a particular technology by a faculty member. A maximum of three hours may be counted towards graduation without prior written CS Department approval. Lab access fee of $35 for computers applies.

CS 305G
Global Social and Ethical Issues in Computing 3:3:0 Fall, Spring
* Prerequisite(s): ENGL 2010 and (CS 1030 or CS 1400 or INFO 1120 or DGM 1110) and University Advanced Standing
Examines how computers have affected global society and how they could further affect it in the future. Challenges students to (1) examine several types of ethical reasoning to establish an ethical framework to assist in making normative judgments, (2) examine various ethical issues surrounding computer usage, particularly in differing societal contexts, (3) understand the responsibilities they bear, to know how their actions can affect both society and individual people in their own and other cultural settings, and to appreciate both the good and the harm they can do and (4) consider many of the moral and professional issues that those who work with computers might expect to face. Lab access fee of $35 for computers applies.

CS 3060
Operating Systems Theory 3:3:0 Fall, Spring
* Prerequisite(s): CS 2420, CS 2810, computer engineering major or (matriculation to computer science or software engineering), and University Advanced Standing
Introduces the Unix operating system. Presents the underlying theory and concepts of an operating system, and covers the following topics in depth: device management, processes, threads, synchronization, scheduling, deadlocks, memory management, virtual memory, and file systems. Provides practical experience in writing programs that use standard Unix system calls to interface directly with the operating system. Most of the programs will be written in the C language. Lab access fee of $35 for computers applies.

CS 3240
Discrete Mathematical Structures II 3:3:0 Fall, Spring
* Prerequisite(s): CS 2300, CS 2420, CS 2810, computer engineering major or (matriculation to computer science or software engineering), and University Advanced Standing
Introduces concepts from discrete mathematics including formal languages, and automata, including Turing machines, regular expressions, grammars, and computability. Lab access fee of $35 for computers applies.

CS 3250
Java Software Development 3:3:0 Fall, Spring
* Prerequisite(s): CS 2420, matriculation to computer science or software engineering major, and University Advanced Standing
Covers object-oriented, functional programming and event-driven features of the Java Programming Language using common libraries, idioms, and software design patterns and principles. Includes abstract classes, interfaces, inner classes, lambda expressions, collections, streams, modern GUIs, I/O, serialization, socket programming, concurrency and parallel multicore programming. Lab access fee of $35 for computers applies.

CS 3260
C#plusNET Software Development 3:3:0 Fall, Spring
* Prerequisite(s): Matriculation to computer science or software engineering and University Advanced Standing
Introduces the C# programming language and the .NET Framework. Discusses the various datatypes, built-in class in namespaces, and how to develop user defined classes and namespaces. Includes programming assignments for console, GUI, and ASP.NET applications. Lab access fee of $35 for computers applies.

CS 3270
Python Software Development 3:3:0 Spring
* Prerequisite(s): CS 2420 or INFO 2200, matriculation to computer science or software engineering major, and University Advanced Standing
Covers the features of the Python programming language. Includes scripting, dynamic typing, data types (sequences, sets, mappings, files, etc.), loops, iterators, generators, functions, coroutines, classes and objects, modules, packages and scope, runtime services, data wrangling, concurrent programming, etc. Lab access fee of $35 for computers applies.

CS 3310
Analysis of Algorithms 3:3:0 Fall, Spring
* Prerequisite(s): MATH 1210, matriculation to computer science or software engineering, and University Advanced Standing
Introduces development and mathematical analysis of fundamental computer algorithms. Teaches divide and conquer and greedy algorithms, dynamic programming, backtracking, branch and bound and NP-completeness. Lab access fee of $35 for computers applies.

CS 3320
Numerical Software Development 3:3:0 Fall, Spring
* Prerequisite(s): MATH 1210, matriculation to computer science or software engineering, and University Advanced Standing
Teaches the tools necessary for modern scientific computation. Covers computer representation of floating-point numbers, error analysis and numerical stability, IEEE floating-point standards, testing of numerical algorithms, calculation of elementary functions, roots of equations, solutions of linear systems, numerical integration and differentiation, interpolation and approximation, Monte Carlo methods. Lab access fee of $35 for computers applies.

CS 3370
C plus plus Software Development 3:3:0 Fall, Spring
* Prerequisite(s): CS 2810, matriculation to computer science or software engineering, and University Advanced Standing
Teaches C++ programming in a production environment, emphasizing mastery of the standard C++ library. Covers the following topics in-depth: const correctness, operator overloading, exception handling, exception-safe design, programming with assertions, automated unit testing, advanced memory management, generic programming with templates, containers, iterators, algorithms, concurrency, and functional programming. Introduces library development, common idioms, and other advanced topics. Emphasizes accepted software engineering practices. Lab access fee of $35 for computers applies.
CS 3380  
JavaScript Software Development  
3:3:0  
Fall  
* Prerequisite(s): CS 2420, CS 2550, matriculation into the CS program, and University Advanced Standing  
Covers modern JavaScript features of functional programming, not JavaScript programming limited to the browser. Topics include rest/spread operators, string interpolation, regular expressions, object property shorthand, computed properties, method properties, destructuring assignments using object and array matching, module export/import, classes & inheritance, promises, iterators, generators, map/set, reflection, localization & formatting. Introduces common idioms and design patterns. Emphasizes accepted software engineering practices.

CS 339R  
Advanced Programming Language Other  
3:3:0  
Not Offered  
* Prerequisite(s): Varies depending on language offered; University Advanced Standing  
Introduces and explores advanced state-of-the-art programming languages and concepts. Investigates topics using language specific analysis, design, Rapid Application Development (RAD), implementation, and testing. Explores language specific syntax, semantics, libraries, the integrated development environment, and debugging techniques. Demonstrates language concepts by developing and writing programs. A maximum of 3 credits will count towards graduation; however, with prior written CNS Department approval more than 3 credits may be counted towards graduation. May be delivered hybrid. Lab access fee of $35 for computers applies.

CS 3410  
Human Factors in Software Development  
3:3:0  
Fall  
* Prerequisite(s): (CS 3250 or CS 3260 or CS 3370 or INFO 2200) and University Advanced Standing  
Studies issues of software analysis, design, and development for and from the perspective of human-computer interaction. Emphasizes design of the human-computer interface, effective presentation of data via graphics, color, text, sound, etc., to the user. Uses development tools for effective graphic presentation, the elements of effective information presentation to users. Lab access fee of $35 for computers applies.

CS 3450  
Principles and Patterns of Software Design  
3:3:0  
Fall, Spring  
* Prerequisite(s): (CS 3250 or CS 3260 or CS 3270 or CS 3370) and University Advanced Standing  
Gives students familiarity with modern principles and practices of software design. Emphasizes design patterns, including their motivation and the design principles on which they are based. Lab access fee of $35 for computers applies.

CS 3520  
Database Theory  
3:3:0  
Fall, Spring, Summer  
* Prerequisite(s): Matriculation to computer science or software engineering and University Advanced Standing  
Introduces theory, concepts, architecture, and use of database management systems (DBMS). Presents the relational and object-oriented database models used in both local and client/server databases. Discusses the Structured Query Language (SQL); database design, normalization theory, and relational calculus relating to database management systems. Lab access fee of $35 for computers applies.

CS 3540  
Game Programming  
3:3:0  
Fall  
* Prerequisite(s): Matriculation to computer science or software engineering and University Advanced Standing  
Teaches techniques for two and three-dimensional graphics programming using DirectX, OpenGL, and/or game engines built on those libraries. Presents concepts of game design that relate to the design and implementation of game software, including procedural generation of assets. Includes application of artificial intelligence concepts to game programming. Introduces the use of network programming techniques for development of multi-player games. May be delivered hybrid. Lab access fee of $35 for computers applies.

CS 3660  
Web Programming II  
3:3:0  
Fall, Spring  
* Prerequisite(s): CS 2420, CS 2550, and one of CS 3250 or CS 3260 or CS 3270 or CS 3370, and University Advanced Standing  
Builds upon concepts taught in CS 2550 Web Programming I. Teaches how to design, implement, test, and debug medium sized web applications using both client and server side technologies. Includes web security, data markup languages, server side scripting technologies, web application interactions with databases, and web service architectures. Teaches how to develop a full web-site having sophisticated user interactions at a variety of security levels. May be delivered hybrid. $35 course fee for computers applies.

CS 3670  
Network Programming  
3:3:0  
Spring  
* Prerequisite(s): CS 2690, CS 3250, and University Advanced Standing  
Covers concept and practical application of socket communication and network protocols. Presents design and implementation of networked applications. May be delivered online. Lab access fee of $35 for computers applies.

CS 3680  
Mobile Device Programming  
3:3:0  
Spring  
* Prerequisite(s): Matriculation to computer science or software engineering and University Advanced Standing  
Teaches software design and programming principles and practices for developing applications for mobile devices. Addresses issues such as application life-cycle, user interfaces on touch-screen devices, options for data storage and communication, power and performance, and using graphics and media. Examines hardware features common in mobile devices such as GPS, accelerometers, and cameras. Lab access fee of $35 for computers applies.

CS 3720  
Database Programming  
3:3:0  
On Sufficient Demand  
* Prerequisite(s): CS 3520 and University Advanced Standing  
Develops the mastery of programming interfaces to local, remote, web and cloud databases. Uses console, Microsoft Windows WPF and web user interfaces. Lab access fee of $35 for computers applies.

CS 4100  
Database Management System Construction  
3:3:0  
Spring  
* Prerequisite(s): CS 3220 or CS 3250 or CS 3260) and University Advanced Standing  
Looks at issues involved in actually implementing a DBMS. Students will implement a relational DBMS. Features of the DBMS include project, select and join, indexing, B + trees, parsing and query optimization. Lab access fee of $35 for computers applies.

CS 4230  
Software Testing and Quality Engineering  
3:3:0  
Fall  
* Prerequisite(s): CS 2450, one of (CS 3250 or CS 3260 or CS 3270 or CS 3370), ECE 3710, and University Advanced Standing  
Provides a comprehensive exploration of strategies for testing computer systems. Includes unit testing, system testing, developing software testing organization, and establishing software Total Quality Management (TQM) programs. Students will conduct system tests of software packages. $35 course fee for computers applies.
CS 4380
Advanced High Performance Computer Architecture
3:3:0 Fall, Spring
* Prerequisite(s): CS 3060, (CS 3370 Recommended), and University Advanced Standing

Presents theory and concepts of high-performance computer architectures. Includes digital logic, buses, registers, ALU’s, control units, pipelining, parallelism, DASD’s, SASD’s, RAID, caching, instruction-sets, memory hierarchy, multiprocessing, interconnection via networks. Lab access fee of $35 for computers applies.

CS 439R
Advanced Current Topics in Computer Science
1 to 3:1 to 3:0 On Sufficient Demand
* Prerequisite(s): Department approval and University Advanced Standing

Provides exposure to emerging technologies and topics of current interest in computer science. Varies each semester depending upon the state of technology. A maximum of 6 hours may be counted toward graduation without CS Department approval. Lab access fee of $35 for computers applies.

CS 4400
Software Engineering II
3:3:0 Fall
* Prerequisite(s): CS 2450, CS 2600, CS 3520, and (CS 3250 or CS 3260 or CS 3270 or CS 3370), and University Advanced Standing
* Prerequisite(s) or Corequisite(s): CS 3450

Covers principles and practices of early phases of software development life cycle. Studies software requirements elicitation, analysis, and design. Includes in-depth, practical study of at least one major software development approach as applied to a realistic organizational systems problem. Explores requirements definition, analysis including prototyping, functional and nonfunctional requirements specification, legacy systems, and architecture patterns. Lab access fee of $35 for computers applies.

CS 4440
Applied 3D Computer Graphics
3:3:0
* Prerequisite(s): CS 2420 with a C or better and (CS 3220 or CS 3250 or CS 3260 or CS 3270 or CS 3370 or CS 339R), and University Advanced Standing

Presents theory and implementation concepts of 2D and 3D computer graphics as used in areas such as computer games, movie special effects, scientific visualization and art. Focuses on the development of applications using an existing cross-platform graphics library rather than on the development of a graphics library. Lab access fee of $35 for computers applies.

CS 4450
Analysis of Programming Languages
3:3:0 Fall, Spring
* Prerequisite(s): CS 3240, (one of CS 3250, CS 3260, CS 3270 or CS 3370) and University Advanced Standing

Offers the mature student an in-depth understanding of the design and implementation of programming languages. Explores criteria for evaluating programming languages as a context for comparing both traditional and current popular languages. Includes the evolution of programming languages, the concept of binding, type checking, static and dynamic scoping, control structures, subprograms and parameter passing methods, and concurrency. Explores the functional programming paradigm in-depth. Includes programming assignments in at least two different programming languages, at least one of which being a functional language such as LISP, Scheme, ML, or Haskell. Lab access fee of $35 for computers applies.

CS 4470
Artificial Intelligence
3:3:0 Fall, Spring
* Prerequisite(s): CS 3240, CS 3310, CS 3320, and (CS 3250 or CS 3260 or CS 3270 or CS 3370), and University Advanced Standing

Presents theory, organization, concepts, and principles of artificial intelligence methodologies including neural networks, expert systems, machine learning algorithms, and genetic algorithms. Lab access fee of $35 for computers applies.

CS 4480
Digital Image Processing and Computer Vision
3:3:0 Spring
* Prerequisite(s): CS 2300, CS 2420, CS 3320, and University Advanced Standing

Prepares students for creating software solutions in the multimedia market of today and into the future. Covers digital sampling of analog signals, basic image processing in the spatial domain and frequency domain, edge and line detection, photo enhancement, feature extraction, and object recognition. May be delivered online. Lab access fee of $35 for computers applies.

CS 4490
Compiler Construction
3:3:0 Fall, Spring
* Prerequisite(s): CS 4380, CS 4450, and University Advanced Standing

Studies theory, analysis and design of class developed compiler. Requires completion of a program level assessment test. Lab access fee of $35 for computers applies.

CS 4500
Advanced Topics in Database
3:3:0 Spring
* Prerequisite(s): (CS 3520 or INFO 3410) and University Advanced Standing

Covers transaction processing, concurrency control techniques, database recovery techniques, database security and authorization, database integrity, distributed databases and client-server architectures, load balancing, data warehousing, data mining, database machines, mobile database, multimedia database, GIS, genome data management, data fragmentation, data encryption, locking, and deadlock. Lab access fee of $35 for computers applies.

CS 4550
Software Engineering III
3:3:0 Spring
* Prerequisite(s): CS 4400, CS 4230, and University Advanced Standing

Senior-level, capstone project experience course. Requires operating as part of a high performance team. Includes completing the design and implementation of a large-scale software development project. Combines major milestone presentations to project clients, completing a portfolio of project-related artifacts, and offer an evaluation of the project and team experience. Requires students to take a program level assessment. Lab access fee of $35 for computers applies.

CS 4610
TCP/IP Internet Architecture
3:3:0 Fall
* Prerequisite(s): CS 2690, matriculation to computer science or software engineering, and University Advanced Standing

Provides theoretical, practical, administrative perspectives of the TCP/IP protocol and its use with the Internet. Includes coverage of IPv4, IPv6, TCP, OSPF and related protocols, IP addressing, subnetting issues, and domain name services are also covered. Lab access fee of $35 for computers applies.
CS 4620
Data Mining
3:3:0 Not Offered
* Prerequisite(s): CS 3520 and University Advanced Standing

Introduces the process of knowledge discovery and the basic theory of automatic extracting models from data, validating those models, solving the problems of how to extract (mine) valid, useful, and previously unknown interesting patterns from a source (database or web) which contains an overwhelming amount of information. Explains various models (decision trees, association rules, linear model, clustering, bayesian network, neural network) and how to apply them in practice. Algorithms applied include searching for patterns in the data, using machine learning, and applying artificial intelligence techniques. Teaches how to implement several relevant algorithms and use existing tools to mine real-world, business driven databases. Lab access fee of $35 for computers applies.

CS 4660
NoSQL Database Development
3:3:0 Fall
* Prerequisite(s): Matriculation into the Computer Science or Software Engineering program, CS 3520, and University Advanced Standing

Introduces theory, concepts, architecture, and use of non-traditional database management systems. Discusses the appropriate use of each in its own niche.

CS 4670
Undergraduate Research Project for Networking Specialization
3:3:0 Spring
* Prerequisite(s): CS 3660, CS 4610, and University Advanced Standing

Creates a system suitable for presentation and defense including project proposal, management plan, system design documentation, relevant testing and benchmarks, and final written and oral reports. Includes system design, systems integration and systems management. Encourages open source and community service projects. Requires completion of a program level assessment test. Lab access fee of $35 for computers applies.

CS 4690
Distributed Internet Application Development
3:3:0 Fall
* Prerequisite(s): CS 3660 and (CS 3250 or CS 3260 or CS 3270 or CS 3370), and University Advanced Standing

Provides experience building significant software solutions that span large heterogeneous networks. Includes heterogeneous operating systems, data stores (SQL and NoSQL), service architectures, remote objects, remote services, and data exchange. Lab access fee of $35 for computers applies.

CS 4770
Software Development for Robotics
3:3:0 On Sufficient Demand
* Prerequisite(s): CS 3370 and University Advanced Standing; CS 4470 recommended

Teaches students through hands on development the intricacies of programming robots such as autonomous vehicles and/or industrial manufacturing robots. Includes behavior based programming, intelligent agents, low level device drivers, sensor calibration and processing, real time programming requirements, motion planning and navigation, and machine learning. Lab access fee of $35 for computers applies.

CS 479R
Advanced Current Topics in Computer Science
1 to 3:0 to 3:0 to 12 On Sufficient Demand
* Prerequisite(s): Department Approval and University Advanced Standing

Provides exposure to emerging technologies and topics of current interest in computer science. Varies each semester depending upon the state of technology. May be repeated for a maximum of 6 credit hours toward graduation without prior written CS Department approval. Lab access fee of $35 for computers applies.

CS 481R
Internship
1 to 8:1 to 8:0 Fall, Spring, Summer
* Prerequisite(s): Matriculation into computer science or software engineering, Instructor Approval, and University Advanced Standing

Provides opportunity to use work experience to add to educational background and academic experience. A maximum of 3 credit hours may be counted towards graduation without prior written CNS Department approval. May be graded credit/no credit.

CS 4880
Cloud Computing
3:3:0 Spring
* Prerequisite(s): Matriculation into the Computer Science or Software Engineering program, CS 4690, and University Advanced Standing

Develops mastery of programming to cloud databases. Emphasizes real-world scenarios involving architecture, build, development, testing, and deployment on commercially available cloud databases. Covers concurrent programming, distributed programming, microservices, migration, and hybrid clouds.

CS 489R
Undergraduate Research Project
2 to 6:2 to 6:0 Not Offered
* Prerequisite(s): Department approval and University Advanced Standing

Combines and integrates concepts, methodologies, and skills developed in previous Computer Science course work. Studies the specification, analysis, design, implementation, and completion of a complex and comprehensive project. Requires a project/ portfolio using project management techniques. A maximum of 3 hours may be counted towards graduation without prior written Computer Science Department approval. Lab access fee of $35 for computers applies.

CS 4900
Full Stack Web Senior Capstone
3:3:0 Spring
* Prerequisite(s): CS 3410, CS 4660, (CS 3250 or CS 3260), and University Advanced Standing

Brings all pieces of full stack web development into a complete capstone project. Covers design, development and deployment of all parts of a web application.

CS 491R
Independent Study
1 to 6:0 to 6:0 to 18 Not Offered
* Prerequisite(s): Prior written Department Chair approval and University Advanced Standing

Offers independent study as directed by a faculty advisor in reading, individual projects, etc. Varies each semester depending upon the state of technology. A maximum of 3 credit hours may be counted towards graduation without prior written Computer Science Department approval. Lab access fee of $35 for computers applies.

CS 4960
Senior Review
1:1:0 Fall, Spring
* Prerequisite(s): CS 2420, CS 2690, CS 2810, CS 3240, CS 3320, CS 3520, (at least one of CS 3250, CS 3260, CS 3270, CS 3370 or CS 3380) and University Advanced Standing

Summarizes and refreshes student mastery of the core areas of computer science, including discrete mathematics, the structure and behavior of computer operating systems, software concurrency, and data communications.

CS 496R
Senior Seminar
1 to 3:0 to 3:0 to 12 Fall, Spring
* Prerequisite(s): University Advanced Standing

Presents current state-of-the-art and/or best-practices topics in a seminar format. A maximum of 3 credits will count towards graduation. Lab access fee of $35 for computers applies.
Utah Valley University

Computer Science

CS 6100
Database Management System Construction
3:3:0 Fall
* Prerequisite(s): Acceptance into the Master of Computer Science program
Explores issues associated with implementing a DBMS. Provides experience designing and implementing a relational DBMS with features such as projection, select and join, indexing, B+ trees, and parsing. Examines database performance and implements query optimization.

CS 6150
Advanced Algorithms
3:3:0 Fall
* Prerequisite(s): Acceptance into the Master of Computer Science program
Explores applications and tradeoffs of state of the art algorithms in parallel/concurrent programming, data search, graphics, graph theory, data structures, mathematical programming, machine reasoning, machine learning, network flow, and other domains. Applies both theory and practice to various projects with a focus on concurrent/parallel programming.

CS 6300
Software Engineering Leadership
3:3:0 Fall
* Prerequisite(s): Acceptance into the Master of Computer Science program
Prepares students to be software project leaders. Evaluates modern software processes and project management. Identifies important roles in software projects and their contribution to project success. Explores interaction of business needs and project development.

CS 6400
Modern Databases
3:3:0 Spring
* Prerequisite(s): Acceptance into the Master of Computer Science program
Evaluates recent trends in database technology, including the history of NoSQL, NoSQL aggregate data, distribution models, and NoSQL consistency. Discusses parallel data analysis, mapReduce, and the challenge of big data 7 V's issues. Explores technologies that compliment big data, including MPP, data mining, cloud computing, data capture, data curation, data visualization, real-time analytics, concurrency and transaction management in a distributed environment, and future trends of modern database technology.

CS 6470
Machine Learning
3:3:0 Spring
* Prerequisite(s): Acceptance into the Master of Computer Science program

CS 6500
Software Architecture
3:3:0 Spring
* Prerequisite(s): Acceptance into the Master of Computer Science program
Evaluates software architecture and the high level design of large scale software systems. Explores common architectural styles and patterns. Teaches techniques of documenting and assessing software architectures. Teaches characteristics of software architecture evolution. Evaluates several large-scale software architectures.

CS 6510
Design and Simulation of Operating Systems
3:3:0 Fall
* Prerequisite(s): Acceptance into the Master of Computer Science program
Analyzes current topics in operating systems design and simulation. Covers modern computer architecture; several types of memory management; current scheduling algorithms for multiple processes; disk management; virtual memory and interprocess communication.

CS 6600
Graduate Project I
3:3:0 Fall
* Prerequisite(s): CS 6300, CS 6510, CS 6400
Teaches the design and development of a walking skeleton with students participating in all aspects of software development, including: requirements elicitation, architecture, design, implementation, testing, and deployment. First semester of a two-semester capstone course.

CS 6610
Graduate Project II
3:3:0 Spring
* Prerequisite(s): CS 6600
Guides through completion and delivery of the large-scale system started in CS 6600. Delivers appropriate system documentation. Teaches the writing and execution of system tests that ensure a high quality system. Must be taken immediately after CS 6600.

CS 6620
Advanced Data Mining and Visualization
3:3:0 Spring
* Prerequisite(s): Acceptance into the Master of Computer Science program; and (CS 3520 or the Departmental Approval)
Explores advanced concepts of data mining and knowledge discovery including sequence mining, audio video mining, and text mining. Analyzes, designs, develops, and evaluates data mining techniques and tools, including data preprocessing, data characterization and comparison, decision trees, association rule mining in large databases, classification and prediction. Uses clustering and cluster analysis and statistical modeling, advanced methods and applications, extracting meaningful patterns from massive datasets using methods such as neural networks and machine learning algorithms.

CS 6700
Advanced Mathematics for Computer Science
3:3:0 Spring
* Prerequisite(s): Acceptance into the Master of Computer Science program
Solves computer science problems using advanced mathematical models. Applies calculus functions of multiple variables, linear equations, matrix algebra, determinants, Gaussian elimination, eigenvalues, linear programming, and finite-state Markov chains.

CS 6730
Advanced Embedded Systems Engineering
3:3:0 Spring
* Prerequisite(s): CS 6510
Provides a hands-on design experience of software design at the system layer where hardware meets software. Explores embedded computing platforms, interacting with the external world, real-time operation, constraints and optimization, and other techniques which are important for building embedded systems that work in the real world. Applies design/implementation/debugging of embedded functionality through a series of projects and homework exercises.

CS 6800
Computer Graphics
3:3:0
* Prerequisite(s): Acceptance into the Master of Computer Science program
Examines both the theory and implementation of modern 3D computer graphics, as well as its application in such areas as computer gaming, special effects, and virtual/augmented reality. Utilizes a modern graphics library. Investigates recent advances from the literature. Provides real-world experience with a 3D graphics engine.