CSSE - COMPUTER SCIENCE & SOFTWARE ENGINEERING (CSSE)

CSSE 120 - Introduction to Software Development 4 Credits

Hours: 3R-3L-4C
Term Available: F,W,S
Graduate Studies Eligible: No
Prerequisites: None

An introduction to programming with an emphasis on problem solving. Problems may include visualizing data, interfacing with external hardware, or solving problems from a variety of engineering disciplines. Programming concepts covered include data types, variables, control structures, arrays, and data I/O. Software development concepts covered include testing, debugging, incremental development, understanding requirements, and version control systems.

CSSE 132 - Introduction to Systems Programming 4 Credits

Hours: 3R-3L-4C
Term Available: F,S
Graduate Studies Eligible: No
Prerequisites: CSSE 120 or CSSE 221 or CSSE 220 (may be taken concurrently) or CSSE 220EL or CSSE 230EL or CSSE RA120

Provides students with understanding of computer system level issues and their impact on the design and use of computer systems.Students will study low-level programming (assembly) and memory operations, representation of various types of data and programs in memory, and resource/efficiency trade-offs. System requirements such as resource management, security, communication and synchronization are studied and basic systems tools for these tasks are implemented.Course topics will be explored using a variety of hands-on assignments and projects.

CSSE 140 - Practical Security I 1 Credit

Hours: 0R-1L-1C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

This is an entry-level introduction to exploiting and securing computer systems, networks, and web sites. This shallow introduction exposes students to various applied cybersecurity topics including Firewalls, SSH, passwords, web security, and basic unix system administration.Through a series of hands-on exercises, students will relate these topics to practical ways to secure computers.

CSSE 141 - Practical Security II 1 Credit

Hours: 0R-1L-1C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: CSSE 140

A second-level introduction to exploiting and securing computer systems, networks, and web sites. This class continues the introduction to applied cybersecurity topics including basic Cryptography, network protocol analysis, reverse engineering, steganography, forensics, and more unix system administration.Students are also introduced to capture-the-flag exercises, which are widely practiced cybersecurity skill competitions.

CSSE 142 - Practical Security III 2 Credits

Hours: 2R-0L-2C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 141

A third-level class on exploiting and securing computer systems, networks, and web sites. This class continues the introduction to applied cybersecurity topics and focus on applying concepts learned in CSSE140/141 to security competitions such as capture-the-flag events. This class exposes students to strategy used in security competitions, teamwork skills for effective competition, and construction of set of exercises used for running a CTF event. Students will work in teams to solve security-oriented problems, apply their skills to create competition challenges/exercises for use in CSSE 141 and for competition training, practice for security competitions, and participate in or run a few security competitions.

CSSE 145 - Cybersecurity Seminar 2 Credits

Hours: 2R-0L-2C
Term Available: See Department
Graduate Studies Eligible: No
Prerequisites: None

This course provides exposure to leading-edge industrial and academic experts in Cybersecurity and Digital Privacy. Topics including the societal, economic, scientific, and psychological impacts of modern areas of cybersecurity and privacy are examined from both practical and theoretical points of view. Students in this class will attend live and view remote or recorded talks from industry/academic experts, read emergent papers on Cybersecurity and Digital Privacy, participate in discussions or debate about the topics, and reflect on the impacts these topics have on their major area of study. May be repeated for credit with approval from the course instructor when topics are different.

CSSE 193 - Preparation for Careers in Computer 1 Credit

Hours: 1R-0L-1C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

Students learn about the nature of graduate school, the application process to graduate school as well as the importance of developing a portfolio or independent work, including scientific papers. Students will learn about research opportunities in the department, the institute, and at other institutions, such as REUs.

CSSE 199 - Professional Experience 1 Credit

Hours: 1R-0L-1C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

The professional experiences course captures the practical work experiences related to the student's academic discipline. Students are required to submit a formal document of their reflections, which communicates how their employment opportunity reinforced and enhanced their academic studies.

CSSE 212 - MSPP – Multicore Systems Programming and Performance 4 Credits

Hours: 3R-3L-4C
Term Available: F,S
Graduate Studies Eligible: No
Prerequisites: None

The development of powerful multicore applications requires the knowledge of basic parallelization strategies and their software-technical implementation. Additionally, knowledge of the hardware and methods for analysis and optimization of performance are mandatory. Lab exercises will be based on Nvidia's Jetson Nano multicomputer, which additionally is equipped with a powerful GPU (Graphics Processing Unit).This course is taught as part of the International Computer Science dual degree program at Hochschule Ulm, Germany.

CSSE 220 - Object-Oriented Software Development 4 Credits

Hours: 3R-3L-4C
Term Available: F,W,S
Graduate Studies Eligible: No
Prerequisites: CSSE 120 or CSSE 220EL or CSSE RA120 or (ENGD 110 and ENGD 120)

Object-oriented programming concepts, including the use of inheritance, interfaces, polymorphism, abstract data types, and encapsulation to enable software reuse and assist in software maintenance. Recursion, GUIs and event handing. Use of common object-based data structures, including stacks, queues, lists, trees, sets, maps, and hash tables. Space/time efficiency analysis. Testing. Introduction to UML.

CSSE 225 - Programming 3 4 Credits

Hours: 3R-3L-4C
Term Available: F,W,S
Graduate Studies Eligible: No
Prerequisites: None

Differences between Java and C++. C++ concepts of object-oriented programming (classes, objects, inheritance, polymorphism). Storage management. Multiple inheritance, operator overloading, friend-concept, exception handling, I/O. Error analysis of programs. Generic programming and introduction to C++ - standard library. This course is taught as part of the International Computer Science dual degree program at Hochschule Ulm, Germany.

CSSE 230 - Data Structures and Algorithm Analysis 4 Credits

Hours: 3R-3L-4C
Term Available: F,W,S
Graduate Studies Eligible: No
Prerequisites: (CSSE 220 or CSSE 230EL) and (MA 112 or MA 107)

This course reinforces and extends students' ability to independently design, develop, and debug object-oriented software that uses correct, clear, and efficient algorithms and data structures. Students study and implement classical data structures such as list, stack, queue, tree, priority queue, hash table, graph, set, and dictionary. Formal efficiency analysis is used to evaluate the complexity of algorithms for these data structures. Students gain proficiency in writing recursive methods. Students design and implement software individually, in small groups, and in a challenging multi-week team project.

CSSE 232 - Computer Architecture I 4 Credits

Hours: 3R-3L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: (CSSE 120 or CSSE 220EL or CSSE 230EL) and ECE 233

Computer instruction set architecture and implementation. Specific topics include historical perspectives, performance evaluation, computer organization, instruction formats, addressing modes, computer arithmetic, ALU design, floating-point representation, single-cycle and multi-cycle data paths, and processor control. Assembly language programming is used as a means of exploring instruction set architectures. The final project involves the complete design and implementation of a miniscule instruction set processor.

CSSE 240 - Principles of Cybersecurity 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: CSSE 120 and (RH 131 or HUM H190 or ENGL H100)

This course introduces ethical, theoretical, and practical issues of information security in interconnected systems of computers. Implications of relevant professional codes of ethics are a recurring theme of the course, as are societal and human impacts on computer system security. Foundational topics include access control matrices and standard system models, as well as policies for security, confidentiality, and integrity. Implementation issues include key management, cipher techniques, authentication, principles of secure design, representation of identity, access control mechanisms, information flow, life cycle issues, and formal evaluation and certification techniques. Additional topics include malicious logic, vulnerability analysis, and auditing. Computer system attack techniques are observed and evaluated in a closed environment to motivate and inform discussion and exploration of computer network defense techniques. Limitations: NOT available to CS or SE majors. Cannot earn credit for both CSSE 240 and CSSE 340.

CSSE 241 - Computing in a Global Society 4 Credits

Hours: 2R-6L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: CSSE 220

The ability to work with colleagues from other cultures and to work on international projects are key assets in today's job market. The centerpiece of this course is a real-world computing project that students develop in cooperation with peers from an institution of higher education in a foreign country. Exposes students to the procedures and complexities of working on projects that span many time-zones and cultures. Additionally, students examine the use and impact of computing in a global community. International travel is required; students will be expected to incur additional expenses (will vary depending on the project, institution, and country). May be repeated once (for free elective credit only) if the country involved is different.

CSSE 242 - Programming in the Community 1,2 Credits

Hours: 1 or 2R-0L-1 or 2C
Term Available: F,W,S
Graduate Studies Eligible: No
Prerequisites: None

Programming in the Community is a unique course where Rose-Hulman students learn how to become teachers in Computer Science for younger students. As the name suggests, students will go teach CS material to K-12 students at their local school. Students will be assigned to a teaching team to take turns leading and helping follow along projects for the K-12 students. Students are expected to join a weekly instructor meeting on Teams, then take two teaching trips into the community per week (40 to 50 minute lessons). Transportation can be arranged for students unable to travel to the school. Students of any major are welcome to join. This class is a very real-world experience. It is a great way to learn leadership and teaching skills while doing great community service. May be repeated up to 12 credit hours.

CSSE 280 - Introduction to Web Programming 4 Credits

Hours: 3R-3L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: CSSE 220 or CSSE 230

Introduction to the client-side and server-side mechanisms for creating dynamic web applications with persistent data storage. Browser-server interaction via HTTP. Static web page creation using current markup and styling languages. Client-side programming with modern scripting languages and the DOM. Server-side programming with emerging web programming languages and frameworks. Persistent data storage with a state-of-the-art database management system. Asynchronous client-server communication via HTTP requests. Development and consumption of REST APIs. Deployment of web applications to cloud platforms or platform as a service providers. Security considerations. This course provides breadth of knowledge of many tools/technologies rather than deep knowledge of any particular tool/technology. No previous experience with Web development is required.

CSSE 286 - Introduction to Machine Learning 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

An introduction to machine learning (ML) systems, with a focus especially on Artificial Intelligence-based systems, versus statistical ones. The course is designed to be useful to students with a basic knowledge of programming and software systems, whether or not they are computer science majors. During the course, students try different machine learning algorithms on data from problems in a domain of interest to them, comparing results with that of other students taking the class, as well as comparing the outcomes of the different algorithms on their own data. A goal of the course is learning how to gain real predictive value from "big data."

CSSE 290 - Special Topics in Computer Science 1-4 Credits

Hours: (1 - 4)R-0L-(1 - 4)C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: None

Selected topics of current interest. May be repeated for credit if topic is different.

CSSE 304 - Programming Language Concepts 4 Credits

Hours: 4R-0L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: CSSE 230

Syntax and semantics of programming languages. Grammars, parsing, data types, control flow, parameter passing, run-time storage management, binding times, functional programming and procedural abstraction, syntactic extensions, continuations, language design and evaluation. Students will explore several language features by writing an interpreter that implements them.

CSSE 313 - Artificial Intelligence 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 230

In this course, we will study modern AI systems, their current accomplishments, positive as well as negative, issues surrounding their training, and their inner workings. We will formalize those systems as pattern recognizers and distinguish them from classical, symbol-manipulating AI. We will study how these systems become so incredibly powerful through a data driven feature learning. We will look at how they represent knowledge and study their reasoning abilities. We will additionally spend some time discussing the projected impact of anticipated systems and study the building of beneficial AI systems.

CSSE 314 - Bio-Inspired Artificial Intelligence 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 230

CSSE 315 - Natural Language Processing 4 Credits

Hours: 4R-0L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: CSSE 230 and (MA 223 or MA 381)

CSSE 330 - Debugging: From Art to Science 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: No
Prerequisites: CSSE 230 and (CSSE 132 or CSSE 332)

Introduction to systematic debugging. Systematic approaches to solving software problems including: defect classification, search space, instrumentation, tool usage, engineering/scientific process. Specific topics include failure stimulation, software debugging tools, problem isolation and size reduction, problem tracking, scientific method as applied to debugging, problem and test automation, program logging, statistical debugging, and data collection.

CSSE 332 - Operating Systems 4 Credits

Hours: 4R-0L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: CSSE 220 and (CSSE 132 or ECE 230)

Students learn fundamental concepts of modern operating systems by studying how and why operating systems have evolved. Topics include CPU scheduling, process synchronization, memory management, file systems, I/O systems, privacy and security, and performance evaluation. Students implement parts of an operating system as a means of exploring the details of some of these topics.

CSSE 333 - Intro to Database Systems 4 Credits

Hours: 3R-3L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: CSSE 230 (may be taken concurrently)

Relational database systems, with emphasis on entity relationship diagrams for data modeling. Properties and roles of transactions. SQL for data definition and data manipulation. Use of contemporary API's for access to the database. Enterprise examples provided from several application domains. The influence of design on the use of indexes, views, sequences, joins, and triggers. Physical level data structures: B+ trees and RAID. Survey of object databases.

CSSE 335 - Introduction to Parallel Computing 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: MA 221 or MA 212

Principles of scientific computation on parallel computers. Algorithms for the solution of linear systems and other scientific computing problems on parallel machines. Course includes a major project on RHIT's parallel cluster. Same as MA 335.

CSSE 340 - Foundations of Cybersecurity 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: CSSE 132 and CSSE 280

This course introduces ethical, theoretical, and practical issues of information security in interconnected systems of computers. Implications of relevant professional codes of ethics are a recurring theme of the course, as are societal and human impacts on computer system security. Foundational topics include access control matrices and standard system models, as well as policies for security, confidentiality, and integrity. Implementation issues include key management, cipher techniques, authentication, principles of secure design, representation of identity, access control mechanisms, information flow, life cycle issues, and formal evaluation and certification techniques. Additional topics include malicious logic, vulnerability analysis, and auditing. Computer system attack techniques are discussed and explored in a closed environment to motivate and inform discussion and exploration of computer network defense techniques.

CSSE 343 - Cybercrime & Digital Forensics 4 Credits

Hours: 2R-2L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: (RH 131 or RH EXMPT or HUM H190 or ENGL H100) and CSSE 132

This course introduces students to "cybercrime," how police investigate these crimes, and what forensics techs use to uncover digital evidence.Students will examine the laws, technologies, tools, and procedures used in the investigation and prosecution of computer crimes through case studies, discussions, ethical debates, and hands-on laboratory exercises that uncover and analyze digital evidence.This class covers topics including: basics of criminal law, collection and chain of evidence, search & seizure procedures, digital trail discovery, data recovery, and smartphone investigation.

CSSE 351 - Computer Graphics 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: (CSSE 220 or CSSE 230) and (MA 221 or MA 212)

Computer graphics algorithms, hardware and software. Line generators, affine transformations, line and polygon clipping, interactive techniques, perspective projection, solid modeling, hidden surface algorithms, lighting models, shading, and graphics standards. Programming assignments and a final project are required.

CSSE 352 - Computer Game Development 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 230

An introduction to designing and developing computer games. Topics include game genres, game design, sprites, game physics, collisions, characters, scripting, graphics, and sound. Students will design and implement their own game using an available game engine.

CSSE 371 - Software Requirements Engineering 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 230 and (RH 330 or ENGL H290) and CSSE 333

Basic concepts and principles of software requirements engineering, its tools and techniques, and methods for modeling software systems. Topics include requirements elicitation, prototyping, functional and non-functional requirements, object-oriented techniques, and requirements tracking.

CSSE 372 - Software Project Management 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 230

Major issues and techniques of project management. Project evaluation and selection, scope management, team building, stakeholder management, risk assessment, scheduling, quality, rework, negotiation, and conflict management. Professional issues including career planning, lifelong learning, software engineering ethics, and the licensing and certification of software professionals.

CSSE 373 - Formal Methods in Specification and Design 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: CSSE 230 and (MA 275 or MA 276)

Introduction to the use of mathematical models of software systems for their specification and validation. Topics include finite state machine models, models of concurrent systems, verification of models, and limitations of these techniques.

CSSE 374 - Software Design 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: CSSE 230

Introduction to the architecture and design of complete software systems, building on components and patterns. Topics include architectural principles and alternatives, design documentation, and relationships between levels of abstraction.

CSSE 375 - Software Construction and Evolution 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: CSSE 374

Issues, methods and techniques associated with constructing software. Topics include detailed design methods and notations, implementation tools, coding standards and styles, peer review techniques, and maintenance issues.

CSSE 376 - Software Quality Assurance 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: CSSE 230

Theory and practice of determining whether a product conforms to its specification and intended use. Topics include software quality assurance methods, test plans and strategies, unit level and system level testing, software reliability, peer review methods, and configuration control responsibilities in quality assurance.

CSSE 386 - Data Mining with Programming 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: CSSE 220 and (MA 212 or MA 221) and CSSE 280 and (MA 223 or MA 381)

An introduction to data mining for large data sets, including data preparation, exploration, aggregation/reduction, and visualization. Elementary methods for classification, association, and cluster analysis are covered. Significant attention will be given to presenting and reporting data mining results.Students may not get credit for both this course and also the MA 384 Data Mining course.

CSSE 393 - Research Skills 1 Credit

Hours: 1R-0L-1C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: CSSE 193

Students will learn key research skills, including how to read a scientific paper, how to review a scientific paper using various review guidelines, how to develop an annotated bibliography, how to develop a poster presentation, and how to develop an oral presentation of scientific work. Students will additionally be introduced to research tools, such as Latex, and Mendeley. Students will create a Senior Thesis or Senior Research Project Proposal as part of the course.

CSSE 394 - Research Lab 1 1 Credit

Hours: 1R-0L-1C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 393

Students practice and engage in the scientific review process by presenting their own work and by reviewing other students' work and responding to feedback on their work. Work to be reviewed includes oral presentations and an end-of-term draft of their work. Additionally, students will engage with several ethical conundrums that pertain to the research process.

CSSE 395 - Research Lab 2 1 Credit

Hours: 1R-0L-1C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: CSSE 394

Students continue to practice and engage in the scientific review process by presenting their own work and by reviewing other students' work and responding to feedback on their work. Work to be reviewed includes oral presentations and an end-of-term draft of their work. Additionally, students will engage in a writing exchange, and they will continue to engage with ethical conundrums that pertain to the research process.

CSSE 400 - CSSE Seminar 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

This course presents an overview of current application areas within computer science and software engineering through the use of practical case studies. Students will undertake their own preparation of one or more case studies and present their results. This course is taught as part of the International Computer Science dual degree program at Hochschule Ulm, Germany.

CSSE 403 - Programming Language Paradigms 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: CSSE 304

A survey of some current and emerging programming languages, focusing on unique language paradigms-ways of structuring solutions or manipulating data. Examples of paradigms include dynamic programming languages, object-oriented programming, highly parallelizable code, and functional programming. Emphasizes developing independent learning techniques that will allow students to acquire skills in new languages quickly. Students will develop basic skills in at least three different languages representing distinct paradigms. They will also be exposed to a selection of other languages. Includes a substantial team project.

CSSE 404 - Compiler Construction 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: CSSE 232 and CSSE 304 and (CSSE 474 or MA 474)

Theory and practice of programming language translation. Lexical analysis, syntax analysis, parser generators, abstract syntax, symbol tables, semantic analysis, intermediate languages, code generation, code optimization, run-time storage management, error handling. Students will construct a complete compiler for a small language.

CSSE 415 - Machine Learning 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: (MA 221 or MA 212) and (MA 223 or MA 381) and (CHE 310 or CSSE 220 or ECE 230 or MA 332 or MA 386 or ME 323 or ME 327)

An introduction to machine learning. Topics include: error metrics, accuracy vs interpretability trade-off, feature selection, feature engineering, bias-variance trade-off, under-fitting vs. overfitting, regularization, cross-validation, the bootstrap method, the curse of dimensionality and dimensionality reduction using the singular value decomposition. Both parametric and nonparametric methods are covered including: k-nearest neighbors, linear and logistic regression, decision trees and random forests, and support vector machines. Same as MA415.

CSSE 416 - Deep Learning 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: MA 212 or MA 221 and (MA 223 or MA 381) and (CHE 310 or CSSE 220 or ECE 230 or MA 332 or MA 386 or ME 327)

An introduction to deep learning using both fully-connected and convolutional neural networks. Topics include: least squares estimation and mean square error, maximum likelihood estimation and cross-entropy, convexity, gradient descent and stochastic gradient descent algorithms, multivariate chain rule and gradient computation using back propagation, linear vs nonlinear operations, convolution, over-fitting vs under-fitting and hyper-parameter optimization, L2, early stopping and dropout regularization, data augmentation and transfer learning. Same as MA416.

CSSE 432 - Computer Networks 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: CSSE 220 or CSSE 230

Organization, design, and implementation of computer networks, especially the Internet. Network protocols, protocol layering, flow control, congestion control, error control, packet organization, routing, gateways, connection establishment and maintenance, machine and domain naming, security. Each of the top four layers of the Internet protocol stack: application (FTP, HTTP, SMTP), transport (TCP, UDP), network (IP), link (Ethernet).

CSSE 433 - Advanced Database Systems 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: CSSE 333

This course covers advanced topics in the design and development of database management systems and their modern applications. Topics to be covered include query processing and, in relational databases, transaction management and concurrency control, eventual consistency, and distributed data models. This course introduces students to NoSQL databases and provides students with experience in determining theright database system for the right feature. Students are also exposed to polyglot persistence and developing modern applications that keep the data consistent across many distributed database systems.

CSSE 434 - Introduction to the Hadoop Ecosystem 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: CSSE 230

This advanced course examines emergent Big Data techniques through hands-on introductions to the various technologies and tools that make up the Hadoop ecosystem. Topics covered include internals of MapReduce and the Hadoop Distributed File system (HDFS), internals of the YARN distributed operating system, MapReduce for data processing, transformation & analysis tools for data at scale (processing terabytes and petabytes of information quickly), scheduling jobs using workflow engines, data transfer tools & real time engines for data processing.

CSSE 435 - Robotics Engineering 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ME 430 or ECE 230

Interdisciplinary course in robotics focusing on communication, software development, kinematics, robot GUI design, sensing, control, and system integration.Labs in the course cover MATLAB GUI development with GUIDE, Denavit-Hartenberg parameters, Arduino programming, Arduino to Android communication, Android app development, and OpenCV4Android image recognition.Students in the course will program an Android + Arduino, 6-wheeled mobile robot with 5 DOF servo arm to participate in an outdoor GPS robotics challenge. Cross-listed with ME 435.

CSSE 443 - Distributed Systems & IT Security 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: None

Building complex distributed information systems requires a systematic approach. This course covers the analysis of existing distributed information systems and provides the ability to model simple new distributed applications with special attention to the trustworthiness, reliability and security of information systems. Topics covered include the main architectural models of distributed systems, describing simple distributed applications according to architecture and function, defining simple communication protocols, the benefits of using middleware, the risks of using distributed systems, and safety measures. This course is taught as part of the International Computer Science dual degree program at Hochschule Ulm, Germany.

CSSE 444 - Real-time Systems 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: None

Students will learn the features and specifications of real-time systems. Topics covered include real-time operating systems and programming languages, design patterns for real-time systems, scheduling, synchronization, hybrid task sets, and applications of real-time systems. This course is taught as part of the International Computer Science dual degree program at Hochschule Ulm, Germany.

CSSE 451 - Advanced Computer Graphics 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: CSSE 351

Advanced topics in computer graphics. Topics will be drawn from current graphics research and will vary, but generally will include ray tracing, radiosity, physically-based modeling, animation, and stereoscopic viewing. Programming assignments and a research project are required.

CSSE 453 - Topics in Artificial Intelligence 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: CSSE 413 or CSSE 313

Advanced topics in artificial intelligence. Topics will vary. Past topics have included machine game playing and machine learning. May be repeated for credit if topic is different.

CSSE 461 - Computer Vision 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: (CSSE 220 or CSSE 230) and (MA 221 or MA 212 or MA 371 or MA 373)

An introduction to 3D computer vision techniques. Both theory and practical applications will be covered. Major topics include image features, camera calibration, stereopsis, motion, shape from x, and recognition.

CSSE 463 - Image Recognition 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: MA 221 or MA 212

Introduces statistical pattern recognition of visual data; low-level visual feature extraction (color, shape, edges); clustering and classification techniques. Applies knowledge to various application domains through exercises, large programming projects in Matlab, and an independent research project. Familiarity with probability distributions will be helpful, but not required.

CSSE 473 - Design and Analysis of Algorithms 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: CSSE 230 and (MA 375) or (MA 276 and MA 374)

Students study techniques for designing algorithms and for analyzing the time and space efficiency of algorithms. The algorithm design techniques include divide-and-conquer, greedy algorithms, dynamic programming, randomized algorithms and parallel algorithms. The algorithm analysis includes computational models, best/average/worst case analysis, and computational complexity (including lower bounds and NP-completeness). Same as MA 473.

CSSE 474 - Theory of Computation 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: (MA 374 and MA 276 and CSSE 230) and MA 375 or (MA 276 and MA 374)

Students study mathematical models by which to answer three questions: What is a computer? What limits exist on what problems computers can solve? What does it mean for a problem to be hard? Topics include models of computation (including Turing machines), undecidability (including the Halting Problem) and computational complexity (including NP-completeness). Same as MA 474.

CSSE 477 - Software Architecture 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: CSSE 374

This is a second course in the architecture and design of complete software systems, building on components and patterns. Topics include architectural principles and alternatives, design documentation, relationships between levels of abstraction, theory and practice of human interface design, creating systems which can evolve, choosing software sources and strategies, prototyping and documenting designs, and employing patterns for reuse. How to design systems which a team of developers can implement, and which will be successful in the real world.

CSSE 479 - Cryptography 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: CSSE 220 and (MA 275 or MA 276)

Introduction to basic ideas of modern cryptography with emphasis on mathematical background and practical implementation. Topics include: the history of cryptography and cryptanalysis, public and private key cryptography, digital signatures, and limitations of modern cryptography. Touches upon some of the societal issues of cryptography. Same as MA 479.

CSSE 480 - WebApp Frameworks w/ AppEngine 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: CSSE 230

Programming cross-platform mobile applications that target Android, iOS, and web mobile devices using programmatic UIs, layouts, reusable components, and data persistence via cloud backends. Emphasis is on hands-on use of these components in application development.Includes a substantial team project including UI mockups, design, development, testing, and presentation.

CSSE 482 - Applied Modern Cryptography 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: CSSE 479 or MA 479

Exploration into current trends of modern cryptography beyond the classical schemes, with emphasis on realizing practical research in code. Topics include primality proving, factor-base methods, cryptanalytic applications of lattice reduction, efficient quantum cryptanalysis (Shor's algorithm), lattice-based cryptography, and post-quantum public-key standards.

CSSE 487 - Senior Research Project I 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: RH 330 or ENGL H290 and CSSE 393 and CSSE 394 (may be taken concurrently)

Individual or group research on an unsolved technical problem. The problem is expected to be at an advanced level and have an appropriate client. A prototype system, a technical report, and a public presentation are required.

CSSE 488 - Senior Research Project II 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 487 and CSSE 395 (may be taken concurrently)

Individual or group research on an unsolved technical problem. The problem is expected to be at an advanced level and have an appropriate client. A prototype system, a technical report, and a public presentation are required.

CSSE 489 - Senior Research Project III 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 488

Individual or group research on an unsolved technical problem. The problem is expected to be at an advanced level and have an appropriate client. A prototype system, a technical report, and a public presentation are required.

CSSE 490 - Special Topics in Computer Science 1-4 Credits

Hours: (1 - 4)R-0L-(1 - 4)C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

Selected topics of current interest. May be repeated for credit if topic is different.

CSSE 491 - Directed Independent Studies 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

Independent study of an advanced subject not included in regularly offered courses. May be repeated for credit if topic or level is different.

CSSE 492 - Undergraduate Research in Computer Science 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

Research under direction of a faculty member. Presentation of preliminary and final results to departmental seminar. Presentation of work at professional meetings or by publication in professional journals is strongly encouraged. May be repeated for credit if topic or level is different.

CSSE 493 - Undergraduate Research in Software Engineering 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

The Computer Science curriculum prepares students for careers in all areas of the computer industry as well as for graduate studies in computer science and computer related fields. Students have also found a computer science major to be excellent preparation for careers in law, medicine, business administration, industrial engineering, biomedical engineering, and other technical and non-technical fields.

CSSE 494 - Senior Thesis I 4 Credits

Hours: 0R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: RH 330 or ENGL H290 and CSSE 393 and CSSE 394 (may be taken concurrently)

Individual study and research of a topic in computer science or software engineering. Topic is expected to be at an advanced level. Research paper and presentation to department seminar are required.

CSSE 495 - Senior Thesis II 4 Credits

Hours: 0R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 494 and CSSE 395 (may be taken concurrently)

Individual study and research of a topic in computer science or software engineering. Topic is expected to be at an advanced level. Research paper and presentation to department seminar are required.

CSSE 496 - Senior Thesis III 4 Credits

Hours: 0R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 495

Individual study and research of a topic in computer science or software engineering. Topic is expected to be at an advanced level. Research paper and presentation to department seminar are required.

CSSE 497 - Senior Capstone Project I 4 Credits

Hours: 0R-0L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: CSSE 371 and CSSE 374

For a capstone experience, students work on a team to complete a three-term software engineering project for an approved client. Students choose from two approaches to complete their capstone: 1) Develop a substantive software product, using defensible software processes. The teams focus on delivering key software development, administrative, and user artifacts to the client. Tasks include project planning, risk analysis, use of standards, prototyping, configuration management, quality assurance, project reviews and reports, team management and organization, copyright, liability, and handling project failure. 2) Investigate a substantive software product or engineering process problem, using a defensible and documented research approach. Tasks include problem analysis, developing alternative solutions, evaluating the solutions via prototyping and iterative processes of investigation, comparing the potential solutions, recording the investigation experience in a research report, and delivering the research artifacts to the client.

CSSE 498 - Senior Capstone Project II 4 Credits

Hours: 0R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: CSSE 497 and CSSE 371 and CSSE 374

For a capstone experience, students work on a team to complete a three-term software engineering project for an approved client. Students choose from two approaches to complete their capstone: 1) Develop a substantive software product, using defensible software processes. The teams focus on delivering key software development, administrative, and user artifacts to the client. Tasks include project planning, risk analysis, use of standards, prototyping, configuration management, quality assurance, project reviews and reports, team management and organization, copyright, liability, and handling project failure. 2) Investigate a substantive software product or engineering process problem, using a defensible and documented research approach. Tasks include problem analysis, developing alternative solutions, evaluating the solutions via prototyping and iterative processes of investigation, comparing the potential solutions, recording the investigation experience in a research report, and delivering the research artifacts to the client.

CSSE 499 - Senior Capstone Project III 4 Credits

Hours: 0R-0L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: CSSE 498 and CSSE 371 and CSSE 374

For a capstone experience, students work on a team to complete a three-term software engineering project for an approved client. Students choose from two approaches to complete their capstone: 1) Develop a substantive software product, using defensible software processes. The teams focus on delivering key software development, administrative, and user artifacts to the client. Tasks include project planning, risk analysis, use of standards, prototyping, configuration management, quality assurance, project reviews and reports, team management and organization, copyright, liability, and handling project failure. 2) Investigate a substantive software product or engineering process problem, using a defensible and documented research approach. Tasks include problem analysis, developing alternative solutions, evaluating the solutions via prototyping and iterative processes of investigation, comparing the potential solutions, recording the investigation experience in a research report, and delivering the research artifacts to the client.