CS 800 - Internship
Credits: 1
Provides an opportunity to apply academic experience in settings associated with future professional employment. A written proposal for the internship must be approved by the department chair. The proposal must specify what the student will learn from the internship, why the student is properly prepared for the internship, and what supervision will be available to the student during the internship. A mid-semester report and a final report are required. Permission required. Computer Science majors only. Cr/F.
Repeat Rule: May be repeated for a maximum of 3 credits.

CS 825 - Computer Networks
Credits: 3
Introduction to fundamental concepts of computer networks and exploration of widely-used networking technologies. Topics include principles of congestion and error control; network routing; local, wireless and access networks; application protocol design; and network programming. In-depth discussion of the Internet suite of protocols.

CS 827 - Software Security
Credits: 3
Mechanisms and implementation of techniques in software security. Various fundamental security topics include cryptography, access control, protocols, software vulnerabilities, and reverse engineering. Prereq: Machine Organization, Assembly Language, Fundamentals of Cybersecurity.

CS 830 - Introduction to Artificial Intelligence
Credits: 3
In-depth introduction to artificial intelligence concentrating on aspects of intelligent problem-solving. Topics include situated agents, advanced search techniques, knowledge representations, logical reasoning techniques, reasoning under uncertainty, advanced planning and control, and learning. Prereq: data structures.

CS 833 - Mobile Robotics
Credits: 3
An introduction to the foundational theory and practices in mobile robotics. Topics include Kinematics of wheeled mobile robots. Seniors for mobile robots, robot navigation and perception, robot vision, localization and mapping of mobile robots. Hands-on experience directed towards implementation with a real robot. Prereq: Programming or permission of instructor.

CS 835 - Introduction to Parallel and Distributed Programming
Credits: 3
Programming with multiple processes and threads on distributed and parallel computer systems. Introduces programming tools and techniques for building applications on such platforms. Course requirements consist primarily of programming assignments. Prereq: Undergraduate course in operating systems fundamentals and computer organization; or permission.

CS 845 - Formal Specification and Verification of Software Systems
Credits: 3
Course focuses on the formal specification and verification of reactive systems, most notably concurrent and distributed systems. Topics relevant to these systems, such as non-determinism, safety and liveness properties, asynchronous communication or compositional reasoning, are discussed. We rely on a notation (T LA+, the Temporal Logic of Actions) and a support tool (TLC, the TLA+ Model Checker). Prereq: Students are expected to be knowledgeable in logic and to be able to write symbolic proofs in predicate calculus. A basic understanding of the notions of assertion, precondition, and post-condition is also assumed.

CS 850 - Machine Learning
Credits: 3
An introduction to fundamental concepts and common methods in machine learning. In addition to theoretical topics, the course involves hands-on experience in making predictions using synthetic and real-world datasets. Prereq: Statistics, Programming or permission of instructor.
CS 853 - Information Retrieval
Credits: 3
Fundamental algorithms and techniques for text processing and text-based information retrieval systems. Topics include how to build an end-to-end information retrieval system, such as a Web search engine. Prereq: Data Structures.

CS 855 - Computer Vision
Credits: 3
Studying techniques that make a machine 'see' and 'understand' the world in a human-like fashion. The course discusses the theory behind common computer vision techniques and trains students on designing their own algorithms for understanding image or video. Prereq: Statistics course, and Programming course or permission of instructor.

CS 857 - Mathematical Optimization for Applications
Credits: 3
This course introduces the foundations of mathematical optimization and reinforces them via applications. The content includes convex optimization, first and second-order methods, constrained problems, duality, linear and quadratic programming, as well as discrete and non-convex optimization. Applications will focus on machine learning methods but also include problems from engineering and operations research. Prereq: MATH 426; Programming proficiency in MATLAB, R, Java, C, Python, or equivalent.
Equivalent(s): MATH 857

CS 858 - Algorithms
Credits: 3
An introduction to important concepts in the design and analysis of algorithms and data structures, including implementation, complexity, analysis, and proofs of correctness. Prereq: understanding of basic data structures, familiarity with proof methods and basic concepts from discrete mathematics and the ability to program with recursion.

CS 861 - Programming Language Concepts and Features
Credits: 3
Explores the main features of modern, high-level, general-purpose programming languages from the user (programmer) standpoint. Students learn how specific features of programming languages can be used effectively in solving programming problems. The course is also an opportunity to use paradigms that expand on simple imperative programming, such as object-oriented, functional and concurrent programming. Prereq: Operating systems fundamentals and Computer organization, some knowledge of Java.

CS 870 - Computer Graphics
Credits: 3
Input-output and representation of pictures from hardware and software points of view; interactive techniques and their applications; three-dimensional image synthesis techniques. Prereq: data structures.

CS 871 - Web Programming Paradigms
Credits: 3
In this course you will learn languages to program the Web. Languages integrated into browsers, like Javascript, and languages invoked on the server, like Ruby. You will also learn about frameworks, like Rails, and various techniques used to support the programming process. In addition, you will learn languages you will need to create, modify and process Web documents. Although we will learn how to read and write in these languages, our primary goal will be on understanding how the design of these multi-paradigm dynamic languages support the process of developing Web applications. Prereq: programming language concepts or permission.

CS 875 - Database Systems
Credits: 3
Database analysis, design, and implementation. Focus on the relational model. Data description and manipulation languages, schema design and normalization, file and index organizations, data integrity and reliability. Usage of selected DBMS. Prereq: Data Structures.

CS 880 - Topics
Credits: 1-4
Material not normally covered in regular course offerings. May be repeated.

CS 898 - Master's Project
Credits: 3
May be repeated up to a maximum of 6 credits. Ct/F.
Repeat Rule: May be repeated for a maximum of 6 credits.

CS 899 - Master's Thesis
Credits: 1-6
May be repeated up to a maximum of 6 credits. Ct/F.

CS 900 - Graduate Seminar
Credits: 1
Regularly scheduled seminars presented by outside speakers, UNH faculty, and graduate students. Topics include reports of research ideas, progress, and results. Cr/F.

CS 920 - Distributed Systems and Algorithms
Credits: 3
Covers fundamental topics in distributed systems: time, global state, synchronization, election, consensus, distributed file systems, security. Also includes a study of several distributed applications. Prereq: Operating System fundamentals or equivalent.

CS 925 - Advanced Computer Networks
Credits: 3

CS 927 - Software Security Analysis
Credits: 3
This course covers advanced research topics in software security. The main focus is automatic software analysis techniques, such as symbolic execution, taint analysis, and fuzz testing.

CS 931 - Planning for Robots
Credits: 3
Students read research papers and perform a research project pertaining to algorithms for planning and decision-making for robots, with an emphasis on autonomous systems. Advanced undergraduate students in Computer Science and graduate students from other disciplines are eligible to take the course with the instructor's permission. Prereq: CS 830 or CS 833 or permission of instructor.
Repeat Rule: May be repeated for a maximum of 9 credits.
CS 933 - Human Robot Interaction  
Credits: 3  
Human robot interaction (HRI) is a multidisciplinary research domain that investigates the issues involved with smooth integration of robots in the human society. This course will discuss the evolution of HRI research over the past two decades with an emphasis on HRI algorithms that promote safe, meaningful, and goal-oriented human-robot interactions. Topics also include experimental design methodologies commonly used in HRI studies. Prereq: CS 830 or CS 833 or CS 850 or instructor's permission.  
Repeat Rule: May be repeated for a maximum of 6 credits.

CS 950 - Advanced Machine Learning  
Credits: 3  
Course covers advanced machine learning techniques for making good decisions driven by data. The main focus areas are reinforcement learning, exploration-exploitation trade-off, mathematical optimization methods, and practical applications. Group-based Project on a selected topic. Prereq: instructor's permission.  
Repeat Rule: May be repeated for a maximum of 9 credits.

CS 953 - Data Science for Knowledge Graphs and Text  
Credits: 3  
This course covers basic and advanced algorithms and techniques for data science with knowledge graph and text data. This includes a wide range of algorithms for graph processing, text processing, and information retrieval with a focus of knowledge graphs and text from knowledge articles. Prereq: CS 853 or Permission of Instructor.

CS 980 - Advanced Topics  
Credits: 3

CS 998 - Independent Study  
Credits: 1-6

CS 999 - Doctoral Research  
Credits: 0

Cr/F.