Computer Science and Data Science Course List

COMP 125/CS 125: Numerical Analysis
Summary: Analysis of algorithms involving computation with real numbers. Covers interpolation, methods for solving linear and nonlinear systems of equations, numerical integration, and numerical methods for solving ordinary differential equations.
Prerequisites: MATH 51 and programming ability in a language such as C, C++, Fortran, or Matlab.

COMP 156-SEN/CS 121: Software Engineering
Summary: Covers major concepts and techniques of software engineering including system requirements, engineering compromises, design methods, coding, testing, team development, and engineering tools. Combines technical focus with project experience across entire software development workflow.
Prerequisites: COMP 40, graduate standing, or instructor consent.

COMP 177/CS 178: Visualization
Summary: Explores visualization as a tool for data analysis, recall, inference, and decision-making. Covers principles of effective visualization including data-visual mapping, interaction techniques, color theory, cognitive psychology, and human factors.
Prerequisites: Comp15 and Comp61, or permission of instructor.

COMP 180/CS 121: Software Engineering
Summary: Focuses on core principles for developing large-scale software systems, emphasizing programming aspects. Covers abstraction, modularity, design patterns, specification, testing, verification, and debugging.
Prerequisites: COMP 40 recommended.

COMP 181/CS 107: Compilers
Summary: Teaches design and implementation of modern compilers, focusing on scanning, parsing, semantic checking, and code generation. Includes a semester-long project to design a small programming language and implement a compiler for it.
Prerequisites: COMP 40, COMP 105, and COMP 170.

COMP 205/DS 205: Principles of Data Science in Python
Summary: Covers fundamentals of Python programming for data analysis, including data structures, algorithms, program design, and coding standards. Explores data preparation, statistical analysis, machine learning, and deep learning applications.
Prerequisites: Not specified.

COMP 250-SCS: Seminar in Computer Science
Summary: Course used to fulfill doctoral student community/ residence requirement. May be taken up to four times for credit.
Prerequisites: Open to PhD and MS-PhD students only.

COMP 250-VIS: Visualization Seminar
Summary: Examines research papers in perceptual theories, cognitive principles, data storage methods, and interactive machine learning related to visual analytics. Aims to help students understand state-of-the-art in these areas and identify potential research directions.
Prerequisites: Some knowledge in building interactive visual interfaces.

COMP 294: Graduate Special Topics / Master's Project
Summary: Guided individual study of an approved topic suitable for a master's design project.
Prerequisites: Consent of the instructor.

COMP 298: Graduate Research
Summary: Guided research on a topic suitable for a doctoral dissertation.
Prerequisites: Not specified.

CS 105: Programming Languages
Summary: Examines principles and application of computer programming languages. Emphasizes ideas and techniques most relevant to practitioners while covering foundations crucial for intellectual rigor, including abstract syntax, lambda calculus, and type systems.
Prerequisites: COMP 15 (Data Structures) and one semester of Discrete Mathematics (COMP/MATH 22 or 61).

CS 106: Virtual Machines & Language Translation
Summary: Covers translation of high-level, functional programming languages to virtual-machine code. Topics include design and implementation of register-based virtual machines, bytecode interpretation, memory management, parsing and unparsing, and code generation.
Prerequisites: Not specified.

CS 111: Operating Systems
Summary: Addresses fundamental issues in operating system design. Covers concurrent processes, synchronization, sharing, deadlock, scheduling, and relevant hardware properties of computer systems.
Prerequisites: COMP 15 and either CS 40 OR EE 14 recommended.

CS 112/CS 151-PIC: Networks & Protocols
Summary: Covers design and implementation of computer communication networks, protocols, and applications, with emphasis on the Internet protocol suite. Includes network architectures, data link protocols, transport, routing, congestion management, addressing, and naming.
Prerequisites: Comp 15 and one of EE 14 or Comp 40.

CS 113: Human Factors in Security and Privacy
Summary: Examines usability and human-computer interaction problems related to privacy and security. Covers HCI methods for measuring usability issues in security and privacy mechanisms, with practical experience in designing and evaluating systems.
Prerequisites: Familiarity with introductory concepts in programming.

CS 114: Network Security
Summary: Explores vulnerabilities, attacks, and mitigations across all layers of the network stack. Covers cryptography, authentication protocols, botnets, firewalls, intrusion detection systems, and communication privacy and anonymity.
Prerequisites: Computer Science 15 or graduate standing.

CS 115: Database Systems
Summary: Covers fundamental concepts of database management systems, including data models, SQL query language, implementation techniques, storage structures, concurrency control, recovery, query processing, and management of unstructured data.
Prerequisites: COMP 15.

CS 116: Introduction to Security
Summary: Takes a systems perspective on host-based and network-based computer security. Covers current vulnerabilities, protection measures, firewalls, and intrusion detection systems with hands-on programming projects.
Prerequisites: Comp 15.

CS 117: Internet-Scale Distributed Systems
Summary: Explores design decisions that enabled the Web's success and derives principles for designing other modern distributed systems. Compares with traditional distributed system designs and studies core Web specifications.
Prerequisites: CS 40 or permission of the instructor.

CS 118: Cloud Computing
Summary: Covers fundamentals of cloud computing, including architecture, scalability, elasticity, performance metrics, programming models, persistent storage, networking, and security. Explores both technical components and distributed system design.
Prerequisites: COMP 15 and (COMP 40 or EE 14) or CS Grad standing or CS postbac.

CS 119: Big Data
Summary: Introduces techniques for collecting, processing, analyzing, and acting on data at internet scale. Covers parallel and distributed database systems, map-reduce infrastructures, scalable platforms for complex data types, and cloud-based computing.
Prerequisites: A beginning course in databases, familiarity with

Python, shell programming, Java, Scala, and SQL.

CS 120: Web Programming and Engineering
Summary: Focuses on web applications as complex systems delivering rich functionality with unique performance, scalability, usability, and security demands. Covers web engineering processes, design, architectures, testing, and modern frameworks.
Prerequisites: Comp 15 and Comp 20, or Consent of Instructor.

CS 122: Parallel Computing
Summary: Teaches programming for modern parallel computer architectures, especially GPUs and multi-core CPUs. Covers multi-threaded programming challenges and developing high-performance software that leverages hardware caches and parallel computation.
Prerequisites: EE 126 or COMP 40 recommended.

CS 126: Numerical Linear Algebra
Summary: Addresses the two basic computational problems of linear algebra: solution of linear systems and computation of eigenvalues and eigenvectors.
Prerequisites: MATH 70 or 72 and COMP 11 recommended.

CS 131: Artificial Intelligence
Summary: Covers history, theory, and computational methods of artificial intelligence. Explores knowledge representation and computational reasoning methods, along with one or two application areas such as expert systems, robotics, computer vision, or natural language understanding.
Prerequisites: Comp 15 and either COMP/MATH 22 or 61 or familiarity with both symbolic logic and basic probability theory.

CS 132: Computer Vision
Summary: Introduces low and intermediate levels of classic and modern Computer Vision. Teaches algorithm design for automatic visual scene analysis, covering fundamentals of image formation, processing, feature detection, segmentation, and multiple views.
Prerequisites: CS 160 and Math 165 recommended.

CS 133: Human-Robot Interaction
Summary: Provides an overview of the interdisciplinary field of human-robot interaction (HRI). Examines the intersection of psychology, human factors engineering, computer science, and robotics through key papers, presentations, and group projects.
Prerequisites: Senior or graduate standing in Computer Science, or permission of instructor.

CS 134: Computational Models in Cognitive Science
Summary: Explores scientific logic of using computational models for testing theories in cognitive science. Covers connectionist and Bayesian models, agent-based simulation, and combining models with

empirical data to test theories.
Prerequisites: COMP 10, 11, or some programming experience recommended.

CS 135: Introduction to Machine Learning
Summary: Provides an overview of methods for computers to learn from data or experience and make decisions accordingly. Covers supervised, unsupervised, and reinforcement learning, and knowledge extraction with applications across multiple domains.
Prerequisites: Comp 15 and COMP/MATH 22 or 61 or consent of instructor.

CS 136: Statistical Pattern Recognition
Summary: Explores statistical foundations and algorithms for machine learning with a focus on Bayesian modeling. Covers classification, regression, regularization, model selection, kernel methods, support vector machines, and Gaussian processes.
Prerequisites: MATH 13 or 42; MATH 46 or 70; EE 104 or MATH 166; CS 40 or CS 105 or a programming course using Matlab.

CS 137: Deep Neural Networks
Summary: Examines deep neural networks and their applications in computer vision and natural language processing. Covers feed-forward, convolutional, and recurrent networks, along with techniques for training, optimization, and regularization.
Prerequisites: COMP 135, MATH 42, and MATH 70 recommended.

CS 138: Reinforcement Learning
Summary: Focuses on agents that must learn, plan, and act in complex, non-deterministic environments. Covers main theory and approaches of Reinforcement Learning, along with software libraries and practical implementations.
Prerequisites: Proficiency in C++, Java, or Python. Prior coursework in Artificial Intelligence and/or Machine Learning highly recommended.

CS 139: Ethics for AI, Robotics, and Human Robot Interaction
Summary: Provides an overview of ethical problems and challenges in AI, robotics, and human-robot interaction. Connects philosophical ethical theories with algorithmic approaches in artificial agents and explores societal implications.
Prerequisites: Senior standing, or permission of instructor. CS/MATH 61 and CS 15 recommended.

CS 140: Advanced Topics Computer Architecture
Summary: Explores modern computer architecture from basic pipelines to advanced processors. Covers techniques for maximizing performance within constraints of memory technology, power consumption, and application parallelism, examining current challenges and research.

Prerequisites: EE126/COMP146 or COMP40 recommended.

CS 141: Probabilistic Robotics
Summary: Covers techniques for probabilistic state estimation and their application to robot localization, mapping, perception, and planning in human-robot interaction contexts. Includes machine learning and computer vision techniques for robots interacting with humans.
Prerequisites: Proficiency in C/C++ or Python recommended.

CS 142: Network Science
Summary: Explores mathematical foundations of graphs and networks that arise in social, biological, and Internet contexts. Covers random graph models, community structure, inference problems, network dynamics, and cascading.
Prerequisites: MATH 70 or 72 or CS 135 or 160 recommended.

CS 144: Iterative Methods in Machine Learning
Summary: Focuses on design and analysis of modern machine learning methods for convex and nonconvex problems across different computational architectures. Covers convergence, complexity, gradient descent variations, and state-of-the-art optimization methods.
Prerequisites: MATH 70 and CS 11.

CS 146: Computer Engineering with Lab
Summary: Teaches advanced computer architecture concepts from basic pipelines to advanced processors. Covers techniques for maximizing single-thread performance and includes hands-on hardware implementation of a MIPS processor in VHDL.
Prerequisites: ES4 and either EE14 or COMP 40 with a 'C' or better.

CS 149: Information Theory
Summary: Explores information theory as a framework for addressing fundamental laws and limits of data compression and digital communication. Covers source coding, information measures, lossless data compression algorithms, channel coding, and rate distortion.
Prerequisites: Undergraduate Probability OR EE 104 OR Permission of instructor recommended.

CS 160: Algorithms
Summary: Introduces algorithm study, covering strategies like divide-and-conquer, greedy methods, and dynamic programming. Includes graph algorithms, sorting, searching, integer arithmetic, hashing, and NP-complete problems.
Prerequisites: COMP 15 and COMP/MATH 22 or 61.

CS 163: Computational Geometry
Summary: Covers design and analysis of algorithms for geometric problems. Topics include convex hulls, searching, plane sweep, Voronoi

diagrams, intersection problems, decomposition, and closest-pairs problems.
Prerequisites: COMP 160, COMP 170, any 100+ MATH course, or permission of the instructor.

CS 166: Computational Systems Biology
Summary: Teaches computational modeling of complex biological systems to analyze emergent properties and predict system behavior. Covers molecular and protein modeling in biochemical networks and applications across biological domains.
Prerequisites: Not specified.

CS 167: Computational Biology
Summary: Addresses computational challenges in molecular biology, including sequence alignment, genomic annotation, microarray data analysis, and proteomics. Covers underlying computational techniques like dynamic programming, hidden Markov models, and search procedures.
Prerequisites: Comp15 and at least one CS course numbered 100 or higher.

CS 168: Convex Optimization
Summary: Covers convex optimization theory and algorithms including convex sets, functions, and optimization problems. Explores duality theory, optimality conditions, and algorithms for solving convex problems with applications in communications and signal processing.
Prerequisites: Math 70 or graduate standing.

CS 169: Statistical Bioinformatics
Summary: Focuses on computational methods and analyses for bioinformatics and biomedical data. Covers statistical methods for heterogeneous high-dimensional biological data, hypothesis assessment, visualization, and simulation.
Prerequisites: CS 11 and (CS/Math 61 or Math 65), or graduate standing recommended.

CS 170: Computation Theory
Summary: Explores models of computation including Turing machines, pushdown automata, and finite automata. Covers grammars, formal languages, context-free languages, regular sets, and important theoretical problems in computer science.
Prerequisites: COMP 15 and COMP/MATH 22 or 61.

CS 171: Human-Computer Interaction
Summary: Introduces human-computer interaction principles and interface design. Covers methodology for designing and testing user interfaces, interaction styles, interface techniques, design guidelines, and user interface management systems.
Prerequisites: COMP 15.

CS 175: Computer Graphics
Summary: Explores fundamentals of computer graphics, including digital image representation, 2D rasterization, 3D rendering techniques, viewing transformations, 3D shape representation, and animation. Assignments require C programming knowledge.
Prerequisites: MATH 42 or 44, and MATH 70 or 72, or graduate standing recommended.

CS 182: Cyber in the Civilian Sector
Summary: Explores cyber issues in the civilian sector, focusing on how the Internet complicates national control of information flow. Covers jurisdictional issues, new technology challenges, criminal activities, and civil infrastructure impacts.
Prerequisites: Not specified.

CS 183: Privacy in the Digital Age
Summary: Introduces legal and regulatory protections for personal data and the evolving nature of digital surveillance and online privacy. Covers threats from public and private sectors and international privacy protection approaches.
Prerequisites: Not specified.

CS 184: Cyberlaw and Cyberpolicy
Summary: Introduces legal issues in cyberspace, examining technology's evolution relative to law. Covers jurisdiction, privacy, surveillance, copyright, and computer fraud from a US perspective with some international context.
Prerequisites: Not specified.

CS 185: Computing for Developing Regions
Summary: Takes an interdisciplinary approach to studying computing technologies in developing regions. Covers low-cost infrastructure, socially relevant technologies, and technology use by underserved communities through case studies and group projects.
Prerequisites: Completion of COMP 15 or graduate standing.

CS 191: Research
Summary: Research on a Computer Science topic culminating in a final paper describing accomplishments. Aims to advance the state of the art under faculty sponsorship.
Prerequisites: Consent.

CS 193: Directed Study
Summary: Guided study of an approved topic.
Prerequisites: Consent.

CS 193-CC: Computational Complexity
Summary: Topic information not provided in detail.
Prerequisites: Consent.

CS 193-GFA: Geometric Folding Algorithms
Summary: Topic information not provided in detail.
Prerequisites: Consent of department.

CS 193-MSC: MS CoreComp
Summary: Topic information not provided in detail.
Prerequisites: Consent of department.

CS 197: Honors Thesis
Summary: Honors Thesis in Computer Science.
Prerequisites: Not specified.

CS 201: Cyber for Future Policymakers
Summary: Explores computer technologies relevant to policy development. Covers Internet architecture, networking, web technologies, cryptography, security, privacy, AI, machine learning, and emerging technologies like quantum computing.
Prerequisites: Graduate standing in a non-CS related discipline; COMP 10 or COMP 11 recommended.

CS 202: How Systems Work
Summary: Graduate version of COMP13 covering how computing systems work at a foundational level. Topics include information representation, CPU operation, assembly language, programming languages, networking, and algorithms.
Prerequisites: Graduate standing in a non-CS related discipline; COMP 10 or COMP 11 recommended.

CS 203: How Systems Fail
Summary: Examines failure of computer systems within the context of complex systems. Covers failures in algorithms, engineering, systems, applications, people, and culture, along with attack recovery and security case studies.
Prerequisites: Graduate standing in a non-CS related discipline.

CS 204: Programming for Data Science
Summary: Covers algorithms for data manipulation, cleaning, and preparation. Explores program design, coding standards, software libraries, and performance optimization for data science applications from basic analysis to deep learning.
Prerequisites: Course in data structures (equivalent to CS 15) and linear algebra (equivalent to Math 70) recommended.

CS 226: Numerical Analysis
Summary: Analyzes algorithms for computation with real numbers, with strong theoretical emphasis. Covers interpolation, solving equation systems, integration, differential equations, and methods for hyperbolic partial differential equations.
Prerequisites: Math 51 or 153, Math 70 or 72, and graduate standing; or permission of instructor.

CS 239: Ethics for AI, Robotics, and Human Robot Interaction
Summary: Explores technical challenges of endowing autonomous agents with normative principles. Connects philosophical ethical theories with algorithmic approaches in artificial agents and analyzes societal implications of AI and robotic technology.
Prerequisites: CS MS or PhD or DS MS or HRI MS.

CS 260: Advanced Algorithms
Summary: Explores modern algorithms and beautiful algorithm design techniques. Covers randomized algorithms, approximation algorithms, online algorithms, and current research areas in algorithmic design.
Prerequisites: Comp 160 or permission of the instructor.

CS 263: Advanced Computational Geometry
Summary: Covers advanced design and analysis of sequential, parallel, probabilistic, and approximation algorithms for geometry problems. Includes geometric data structures, complexity, searching, computation, and applications.
Prerequisites: CS 163 or permission of instructor recommended.

CS 288/DS 288: Master of Science Capstone Project I
Summary: First part of a two-course capstone for MS programs. Focuses on requirements analysis, design, project planning, management, and proof-of-concept prototyping for a comprehensive programming or data science project.
Prerequisites: CS 180 or 121, and enrollment in the Master of Science program.

CS 289/DS 289: Master of Science Capstone Project II
Summary: Second part of the two-course capstone for MS programs. Implements the project defined in part one, including testing, documentation, maintenance, and release management, culminating in final project presentation.
Prerequisites: CS 288/DS 288, and enrollment in the Master of Science program.

CS 291: Seminar in Computer Science
Summary: Weekly seminar with guest speakers discussing research challenges and recent advances in Computer Science. Pass/fail based on attendance and feedback for at least 50% of seminars.
Prerequisites: Ph.D. standing in Computer Science.

CS 293: Graduate Special Topics / Master's Project
Summary: Guided individual study of an approved topic suitable for a master's design project.
Prerequisites: Permission of the instructor.

CS 295: Master's Thesis
Summary: Guided research on a topic approved as suitable for a

master's thesis.
Prerequisites: Not specified.

CS 296: Master's Thesis
Summary: Guided research on a topic approved as suitable for a master's thesis.
Prerequisites: Not specified.

CS 297: Graduate Research
Summary: Guided research on a topic suitable for a doctoral dissertation.
Prerequisites: Not specified.

CS 299/DS 299: Internship in Computer Science/Data Science
Summary: Study of approved topics in Computer Science or Data Science in conjunction with an internship in computing or related field outside the University.
Prerequisites: Permission of instructor.

CS 401: Master's Continuation Part-Time
Summary: Maintains active status for Master's students working part-time.
Prerequisites: Not specified.

CS 402: Master's Continuation Full-Time
Summary: Maintains active status for Master's students working full-time.
Prerequisites: Not specified.

CS 404: Graduate Engineering Co-op
Summary: Graduate-level cooperative education work experience.
Prerequisites: Not specified.

CS 405: Graduate Teaching Assistant
Summary: Registration for graduate teaching assistant positions.
Prerequisites: Not specified.

CS 406: Graduate Research Assistant
Summary: Registration for graduate research assistant positions.
Prerequisites: Not specified.

CS 501: Doctoral Continuation Part-Time
Summary: Maintains active status for doctoral students working part-time.
Prerequisites: Not specified.

CS 502: Doctoral Continuation Full-Time
Summary: Maintains active status for doctoral students working full-time.
Prerequisites: Not specified.