Coursework with Course Descriptions

Computer Science and Computational Coursework:

Computability and Logic (CSCI081 HM)

An introduction to some of the mathematical foundations of computer science, particularly logic, automata and computability theory. Develops skill in constructing and writing proofs, and demonstrates the applications of the aforementioned areas to problems of practical significance. Topics include: formal deductive reasoning, classic propositional logic, truth-functional equivalence, predicate logic, decision problems, universal Turing machines, diagonalization, reduction, Rice's theorem, the recursion theorem, grammars and languages, the Myhill-Nerode theorem, regular expressions, Chomsky normal form, the Cocke–Younger–Kasami algorithm, and pushdown automata.

Algorithms (CSCI140 HM)

Algorithm design, analysis, and correctness. Design techniques including divide-and-conquer and dynamic programming. Analysis techniques including solutions to recurrence relations and amortization. Correctness techniques including invariants and inductive proofs. Applications including sorting and searching, graph theoretic problems such as shortest path and network flow, and topics selected from arithmetic circuits, parallel algorithms, computational geometry, and others. An introduction to computational complexity, NP-completeness, and approximation algorithms.

Data Structures/Program Development (CSCI070 HM)

Abstract data types including priority queues and dynamic dictionaries and efficient data structures for these data types, including heaps, self-balancing trees and hash tables. Analysis of data structures including worst-case, average-case and amortized analysis. Storage allocation and reclamation. Secondary storage considerations. Extensive practice building programs for a variety of applications.
(Language used: C++)

High Performance Computing / Computer Science Seminar (CSCI181J HM)

This applied special-topics course is designed to introduce students to many of the technologies and techniques that are essential to modern high-performance computing. The target audience for the course is CS majors, though interested and experienced programmers from other majors are welcome. We'll talk about how to programmatically leverage multicore processors, caching, GPUs, clusters, and

SIMD operations. Student grades are based entirely on weekly homework assignments, which are divided into three parts: prescribed exercises, open-ended problems that ask the students to illustrate the current concept by coming up with an illustrative example and analyzing it, and finally short answer problems in which students explain the concept to a non-technical audience. The course will progressively cover single core, multi-core, GPU, and finally multi-processor programming. As a driving and recurring example, students will implement course topics in their own 1D finite difference wave equation solver, the background for which will be provided in class. All classwork will be done in C/C++, with a few examples in Python and some emergent programming languages for performative comparison. **(Languages and APIs used: C++, C, MPI, OpenMP, CUDA)**

Principles of Computer Science (CSCI060 HM)

Introduction to principles of computer science: Information structures, functional programming, object-oriented programming, grammars, logic, logic programming, correctness, algorithms, complexity analysis, finite-state machines, basic processor architecture and theoretical limitations. **(Languages used: Java, Prolog, Racket)**

Introduction to Computer Science (CSCI005 HM)

Introduction to elements of computer science. Students learn computational problem-solving techniques and gain experience with the design, implementation, testing and documentation of programs in a high-level language. In addition, students learn to design digital devices, understand how computers operate, and learn to program in a small machine language. Students are also exposed to ideas in computability theory. The course includes discussions of societal and ethical issues related to computer science. **(Language used: Python)**

Computational Methods in Physics (PHYS170 HM)

Typical numerical methods for solving a wide range of problems of current interest in physics. Examples are drawn from mechanics, electromagnetism, quantum mechanics, statistical mechanics, solid state and chemical physics. **(Language used: Mathematica)**

Mathematics Coursework:

Discrete Mathematics (MATH055 HM)

Topics include combinatorics (clever ways of counting things), number theory, and graph theory with an emphasis on creative problem solving and learning to read and write rigorous proofs. Possible applications include probability, analysis of algorithms, and cryptography.

Differential Equations/Linear Algebra II (MATH065 HM)

General vector spaces and linear transformations; change of basis and similarity. Applications to linear systems of ordinary differential equations, matrix exponential; nonlinear systems of differential equations; equilibrium points and their stability.

Intermediate Probability (MATH157 HM)

Continuous random variables, distribution functions, joint density functions, marginal and conditional distributions, functions of random variables, conditional expectation, covariance and correlation, moment generating functions, law of large numbers, Chebyshev's theorem and central-limit theorem.

Probability and Statistics (MATH035 HM)

Sample spaces, events, axioms for probabilities; conditional probabilities and Bayes' theorem; random variables and their distributions, discrete and continuous; expected values, means, and variances; covariance and correlation; law of large numbers and central limit theorem; point and interval estimation; hypothesis testing; simple linear regression; applications to analyzing real data sets.

Fourier Series/Boundary Value Problems (MATH115 HM)

Complex variables and residue calculus; Laplace transforms; Fourier series and the Fourier transform; Partial Differential Equations including the heat equation, wave equation, and Laplace's equation; Separation of variables; Sturm-Liouville theory and orthogonal expansions; Bessel functions.

Intro to Differential Equations (MATH045 HM)

Modeling physical systems, first-order ordinary differential equations, existence, uniqueness, and long-term behavior of solutions; bifurcations; approximate solutions; second-order ordinary differential equations and their properties, applications; first-order systems of ordinary differential equations.

Intro to Linear Algebra (MATH040 HM)

Theory and applications of linearity, including vectors, matrices, systems of linear equations, dot and cross products, determinants, linear transformations in Euclidean space, linear independence, bases, eigenvalues, eigenvectors, and diagonalization.

Multivariable Calculus (MATH060 HM)

Linear approximations, the gradient, directional derivatives and the Jacobian; optimization and the second derivative test; higher-order derivatives and Taylor approximations; line integrals; vector fields, curl, and divergence; Green's theorem, divergence theorem and Stokes' theorem, outline of proof and applications.

Calculus (MATH030G HM)

A comprehensive view of the theory and techniques of differential and integral calculus of a single variable; infinite series, including Taylor series and convergence tests. Focus on mathematical reasoning, rigor and proof, including continuity, limits, induction. Introduction to multivariable calculus, including partial derivatives, double and triple integrals.

Putnam Seminar (MATH093 HM)

This seminar meets one evening per week during which students solve and present solutions to challenging mathematical problems in preparation for the William Lowell Putnam Mathematics Competition, a national undergraduate mathematics contest.

Physics Coursework:

General Relativity & Cosmology (PHYS172 HM)

The principle of equivalence, Riemannian geometry and the Schwarzschild and cosmological solutions of the field equations.

Statistical Mechanics/Thermodynamics (PHYS117 HM)

Classical and quantum statistical mechanics, including their connection with thermodynamics. Kinetic theory of gases. Applications of these concepts to various physical systems.

Quantum Mechanics (PHYS116 HM)

The elements of nonrelativistic quantum mechanics. Topics include the general formalism, one-dimensional and three-dimensional problems, angular momentum states, perturbation theory, and identical particles. Applications to atomic and nuclear systems.

Theoretical Mechanics (PHYS111 HM)

The application of mathematical methods to the study of particles and of systems of particles; Newton, Lagrange and Hamilton equations of motion; conservation theorems; central force motion, collisions, damped oscillators, rigid body dynamics, systems with constraints, variational methods.

Electromagnetic Fields (PHYS151 HM)

The theory of static and dynamic electromagnetic fields. Topics include multipole fields, Laplace's equation, the propagation of electromagnetic waves, radiation phenomena and the interaction of the electromagnetic field with matter.

Quantum Physics (PHYS052 HM)

The development and formulation of quantum mechanics, and the application of quantum mechanics to topics in atomic, solid state, nuclear and particle physics.

Electromagnetic Theory & Optics (PHYS051 HM)

An introduction to electricity and magnetism leading to Maxwell's electromagnetic equations in differential and integral form. Selected topics in classical and quantum optics.

Gravitation (PHYS032 HM)

The theory and applications of Newtonian gravitation and an introduction to the ideas of gravitation in general relativity. Topics covered include gravitational potentials, orbits and celestial mechanics, tidal forces, atmospheres, Einstein's equivalence principle, black holes and cosmology.

Mechanics & Wave Motion (PHYS024 HM)

Kinematics, dynamics, linear and angular momentum, work and energy, harmonic motion, waves and sound.

Special Relativity (PHYS023 HM)

Time dilation, length contraction, Lorentz transformations, spacetime, relativistic momentum and energy; conservation laws.

Physics Colloquium (PHYS195/196 HM)

Oral presentations and discussions of selected topics, including recent developments. Participants include physics majors, faculty members and visiting speakers.

Optics Laboratory (PHYS134 HM)

A laboratory-lecture course on the techniques and theory of classical and modern optics. Topics of study include diffraction, interferometry, Fourier transform spectroscopy, grating spectroscopy, lasers, quantum mechanics and quantum optics, coherence of waves and least-squares fitting of data.

Electronics Laboratory (PHYS133 HM)

An intermediate laboratory in electronics involving the construction and analysis of rectifiers, filters, transistor and operational amplifier circuits.

Modern Physics Laboratory (PHYS054 HM)

Classical experiments of modern physics, including thermal radiation and Rutherford scattering. Nuclear physics experiments, including alpha, beta and gamma absorption, and gamma spectra by pulse height analysis. Analysis of the buildup and decay of radioactive nuclei.

Physics Laboratory (PHYS022 HM)

This course emphasizes the evidence-based approach to understanding the physical world; students design, conduct, and interpret experiments to give quantitative answers to physical questions. Topics are drawn from a broad range of physics subjects, with applications to other technical fields.

Philosophy Coursework:

Classical Liberalism/Libertarianism/Special Topics in Philosophy (PHIL179A HM)

"Libertarianism" and "classical liberalism" refer to a family of views that aim to maximize a certain conception of individual freedom and, in this connection, that advocate a minimal role for the state. Despite these similarities, however, such views probably show as many differences as similarities, both in their specific claims about how societies should be organized and (especially) in the kinds of arguments they put forward to support these claims. This course takes a comparative, critical look at several important statements of a classical liberal or libertarian position by philosophers and social theorists of the twentieth and twenty-first centuries. Authors will include Friedrich Hayek, Ludwig von Mises, Ayn Rand, Robert Nozick, Richard Epstein, and others. Toward the end of the semester we'll read two recent books pushing back against standard libertarianism (Libertarianism Without Inequality by Michael Otsuka and The Myth of Liberal Individualism by Colin Bird).

Special Topics in Philosophy - Philosophy of Film (PHIL178 CM)

A survey of recent work on questions such as: how should we define film? Is it a genuine art form? What distinguishes documentary from fictional film? Who is the narrator in a narrative film? Why do fictional films move us emotionally? Are there rules to film criticism? Could film be a source of knowledge? Does watching certain films make us morally better or worse? Readings will be drawn from Noel Carroll, Gregory Currie, Kendall Walton, George Wilson, and many others.

Ethical Theory (PHIL121 HM)

A survey of contemporary philosophical thinking about morality, emphasizing how metaethical inquiry into the nature of "goodness," "virtue" and "moral obligation" can inform normative inquiry into what is good and how to live. Attention is given throughout the course to the application of particular normative theories to personal decision-making and to contemporary social and political questions.

Political Philosophy (PHIL130 HM)

The major traditions of political thought from antiquity to the present, with emphasis on the modern era, including natural rights theory, social contract theory, political individualism and its critics, the twentieth-century transformation of political liberalism, and the underpinnings of contemporary conservatism.

Art and Aesthetics (PHIL070 PO)

The course focuses on issues concerning the nature of art and its value. Issues include the role of interpretation in determining the meaning of artworks; the question of whether forgery that is visually identical to an original work has less aesthetic—value and if so, why; and problems arising from certain kinds of artworks, like why we have emotional responses to fictional characters and whether it is rational to do so.

Logic (PHIL060 PO)

Introduction to mathematical logic through the development of proof techniques (natural deduction and semantic tableaux) and model theory for sentential logic and quantification theory. Properties of logical systems, such as consistency, completeness and decidability.

Chemistry Coursework:

Dynamics (CHEM023D HM)

Kinetics, equilibria and acid/base chemistry.

Energetics (CHEM023E HM)

Phase behavior, equations of state, intermolecular forces, thermodynamics, and electrochemistry.

Structure (CHEM023S HM)

Molecular and electronic structure, intermolecular forces, condensed phases, organic structure and properties and biopolymers.

Chemistry Laboratory (CHEM024 HM)

Applications of thermodynamics, equilibria, electrochemistry, structure/property relationships, synthesis, spectroscopy and chemistry in the service of society.

Miscellaneous Classwork:

Intro to Engineering Systems (ENGR059 HM)

An introduction to the concepts of modern engineering, emphasizing modeling, analysis, synthesis and design. Applications to chemical, mechanical and electrical systems. **(Language used: Matlab)**

Financial Economics (ECON104 HM)

The principles of money and banking from the viewpoint of both business person and banker. Topics include the operation of commercial banks, related financial institutions, the development of the banking system, international finance, governmental fiscal and monetary policy, and the relations of money and credit to prices.

Introduction to Computer Music (MUS 088 HM)

The basics of using software on a general purpose computer to synthesize and manipulate digital sounds. **(Language used: Csound)**

Introduction to Academic Writing: Science Communication in the Popular Press (WRIT001 HM)

A seminar devoted to effective writing strategies and conventions that apply across academic disciplines. The course emphasizes clarity, concision, and coherence in sentences, paragraphs, and arguments.

History of Modern Physics (HIST152 HM)

An examination of the cultural and social worlds of physics in the 19th and 20th centuries. Topics include the relationship of experiment to theory, the development of relativity and quantum mechanics, the role of physicists in the atomic bomb project, and the experiences of women in physics.

Core Lab - The Chemistry of Cooking (CL 057 HM)

Laboratory course emphasizing experiential learning.

Critical Inquiry – Evidence (HSA 010 HM)

This course introduces students to inquiry, writing, and research in HSA (the Harvey Mudd College Department of Humanities, Social Sciences, and the Arts), through focused exploration of a particular topic selected by the instructor in each section. To encourage reflection of the place of HSA within the

HMC curriculum, the course begins with a brief unit on the history and aims of liberal arts education.

German Composition and Creative Writing (GERM104 PO)

This course provides students with intensive practice in expository and critical creative writing , introducing them to German stylistics, the varieties of essay construction, and general principles of short nonfiction and fiction writing. Students analyze, discuss, write about, emulate and produce a wide range of texts in different genres, thereby enhancing their writing skills as well as their reading, listening and speaking abilities.

Introduction to Biology (BIOL052 HM)

Topics in genetics, molecular biology and evolution.