Patrick Rall - Undergraduate Courses at Caltech

The following is an (incomplete) list of courses taken during my undergraduate studies at Caltech. I have only included courses relevant to research in physics, and provided short descriptions of each. Detailed descriptions of each course are available at http://catalog.caltech.edu/.

Core

Ma1abc Calculus of One and Several Variables and Linear Algebra.
Ma2ab Differential Equations, Probability and Statistics.
Ph1abc Classical Mechanics and Electromagnetism.
Ph12ac Waves and Statistical Mechanics.
Ch1ab, Ch3a General Chemistry, Techniques of Experimental Chemistry.

Physics Major

Ph3, Ph6, Ph7 **Physics Laboratory Courses** (Instructor: Frank Rice)
Experiments in electromagnetic phenomena, atomic and nuclear physics: e.g. mobilities of ions in gases, precise measurement of the electron e/m ratio, Balmer series of hydrogen and deuterium, the Stern-Gerlach experiment.

Ph125abc **Quantum Mechanics** (Instructors: Mark Wise, Clifford Chuang)
A one-year course in quantum mechanics and its applications. Wave mechanics in 3-D, scattering theory, Hilbert spaces, matrix mechanics, angular momentum, symmetries, spin-1/2 systems, approximation methods, identical particles, and selected topics in atomic, solid-state, nuclear, and particle physics.

Ph106abc **Topics in Classical Physics** (Instructors: Sterl Phinney, Sunil Golwala)
An intermediate course in the application of basic principles of classical physics to a wide variety of subjects. Roughly half of the year will be devoted to mechanics, and half to electromagnetism. Topics include Lagrangian and Hamiltonian formulations of mechanics, small oscillations and normal modes, boundary-value problems, multipole expansions, and various applications of electromagnetic theory.

ACM95abc Introductory Methods of Applied Mathematics for the Physical Sciences.

Ph127a **Statistical Physics of Particles** (Instructor: Gil Refael)
A course in the fundamental ideas and applications of classical and quantum statistical mechanics. Topics to be covered include the statistical basis of thermodynamics; ideal classical and quantum gases (Bose and Fermi).

Ph5 **Analog Electronics for Physicists** (Instructor: Frank Rice)
A laboratory course on practical electronic circuits, with emphasis on analog electronics.

Ph135b **Quantum Optics** (Instructors: Jeff Kimble, Oskar Painter)
An overview of modern Quantum Optics with particular emphasis on quantum measurement science, the quantum-classical interface, quantum networks, and quantum many-body physics with atoms and photons. The course will concentrate on the essential roles of manifestly quantum (i.e., nonclassical) and entangled states of light and matter. The course combines examples on both theory and experiment from the current research literature.

Ph101 **Order-of-Magnitude Physics** (Instructors: Sterl Phinney, Gil Refael)
Using basic physics to understand complicated systems and calculate their properties up to an order of magnitude.

Ph77ab (2015-2016) **Advanced Physics Laboratory** (Instructors: Kenneth Libbrecht, Eric Black)
Intensive laboratory course with condensed matter, electronics, atomic physics and optics tracks. In fall 2015 I took the optics track, which involved saturated absorption spectroscopy, Fabry-Perot cavities, FM spectroscopy and Pound-Dever-Hall laser locking.

Ph219 (2015-2016) **Quantum Computation** (Instructors: Alexei Kitaev, John Preskill)
Overview of classical information theory, compression of quantum information, transmission of quantum information through noisy channels, quantum error-correcting codes, quantum cryptography and teleportation. Overview of classical complexity theory, quantum complexity, efficient quantum algorithms, fault-tolerant quantum computation, physical implementations of quantum computation.

Computer Science Minor

CS1, CS2 Introduction to Computer Programming and Programming Methods
CS24 Introduction to **Computing Systems**: Hardware-software interface, computer architecture, operating systems.
CS11 **Project Class**: Web-based Window Manager.
CS21 **Decidability and Tractability**: Introduction to the formal foundations of computer science.
CS38 Introduction to **Algorithms**: Introduces techniques for the design and analysis of efficient algorithms.
Ma121 (Fall 2015) **Combinatorial Analysis**: A survey of modern combinatorial mathematics, starting with an introduction to graph theory and extremal problems. Counting, recursion, and generating functions. Theory of partitions. Latin squares, finite geometries, combinatorial designs, and codes. Algebraic graph theory, graph embedding, and coloring.