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Courses Taught

Introductory Physics Lab for engineers, scientists, liberal arts majors, and life-science majors. One year, trigonometry-based and calculus-based courses. These courses teach students how to take data, do error analysis, maintain a laboratory notebook, and report experimental findings. The texts were written by instructors at the colleges where the labs were taught. I wrote my own handouts describing the laboratory procedures at Elizabethtown College.

Introductory Physics for life-science majors, scientists, and engineers. Three semester, trigonometry-based and calculus-based courses. Each sequence of courses introduces (at the appropriate mathematical level) kinematics, dynamics, thermodynamics, statics, fluids, electricity and magnetism, optics, relativity, quantum mechanics, nuclear and atomic physics, and particle physics. Texts: *Physics for Scientists and Engineers* by Serway & Jewett; *General Physics* by D.C. Giancoli. I turned the first two semesters of the algebra-based version into an online course in Canvas using *Physics in Biology and Medicine* by P. Davidovits. I turned the first semester of the calculus-based version into an online course in Canvas using Hands-On Labs, WebAssign, and MATLAB Grader.

Introductory Mathematics for Physics for engineers and scientists. One semester course covering algebra, straight lines, quadratic equations, trigonometry, vectors, complex numbers, sinusoids, systems of equations, derivatives, integrals, and differential equations. MATLAB is introduced and used throughout the course. Text: *Introductory Mathematics for Engineering Applications* by Rattan & Klingbeil.

Freshman Seminars titled, “Mysteries of the Cosmos,” “The Universe: Cosmos or Chaos,” “God and the New Physics,” “The Mind of God,” “Romancing the Universe,” “How Do You Know? Spiritual & Rational Realms of Knowledge,” and “Mind & Brain.” One semester, non-mathematical courses. The Freshman Seminar is designed to introduce first-semester students to college-level academics, familiarize them with the library, polish their communications skills, and inspire them to greater academic achievement. Texts: *Cycles of Fire* by W.K. Hartmann and R. Miller; *The Capricious Cosmos* by Joe Rosen; *God and the New Physics* by P. Davies; *The Mind of God,* by P. Davies; *Romancing the Universe* by J.G. Sobosan; *Mapping the Mind* by Rita Carter; *Consciousness: An Introduction* by Susan Blackmore; *Conscious* by Annaka Harris.

Cosmology. One semester, non-mathematical course. A study of the origin, evolution, and large scale structure of the universe according to various scientific theories; the history of cosmology and its interactions with society; world views associated with nihilism, existentialism, holism, reductionism, the anthropic principles, and the theistic principle. Text: *Cosmology: Historical, Literary, Philosophical, Religious, and Scientific Perspectives* edited by N.S. Hetherington.

Astronomy with lab. One semester, algebra-based course. A study of the structure and evolution of stars, planetary systems, galaxies, and the universe. Less familiar astronomical objects such as black holes, quasars, cosmic strings, texture, and wormholes are also studied. Laboratories provide an opportunity to observe planets, stars, clusters, nebulae, and galaxies; they also provide practical experience in determining astronomical quantities. Text: T*he Cosmic Perspective* by Jeffrey Bennett *et al*.

Earth in Space. One semester, non-mathematical introduction to Big Bang cosmology, galaxies, stellar evolution, planetary formation, the solar system, physical geology, Earth's interior & physical properties, the sea floor, plate tectonics, mountain belts, the continental crust, structural geology, earthquakes & seismology, igneous rocks & the rock cycle. Text: *Earth in Space: The Evolution of a Planet*, Custom Text.

How Things Work. One semester, non-mathematical introduction to concepts in physics related to commonly used technology and processes experienced in daily life. Topics covered: Motion (skating, projectiles, wheels, bumper cars), Mechanics (scales, baseball, amusement parks, bicycle), Resonance (musical instruments), Optics (camera, telescope), Modern Physics (relativity of simultaneity, quantum non-locality), and Astronomy (celestial motions). Text: *How Things Work: The Physics of Everyday Life* by Louis A. Bloomfield. Also taught online in Canvas with lab.

Introductory Acoustics. One semester, algebra-based creative expression course. A study of the fundamentals of musical sound produced by wind and string instruments. The course covers vibrational and oscillatory motion, waves, types of sound, science and aesthetics, scales, pitch, beats, power and loudness, consonance, dissonance, chords, and harmony. Text: *Musical Acoustics* by D.A. Hall.

History & Philosophy of Science. One semester, non-mathematical course offered through the Department of Philosophy. An examination of the scientific method and scientific models, as well as an analysis of the impact of science upon the modern world. The limitations of science are also addressed. Texts: *Philosophy of Science, The Central Issues* edited by Martin Curd & J.A. Cover; *Worldviews: An Introduction to the History and Philosophy of Science* by Richard Dewitt; *An Introduction to the Philosophy of Physics* by Marc Lange.

Physics for Bio-Nanotechnology. One semester, calculus-based course offered at Harrisburg University. Topics include surface-to-volume ratios, quantum mechanics, covalent bonding, ionic bonding, Fermi energy, Boltzmann distribution function, Fermi-Dirac distribution function, metallic solids, covalent solids, laser, population inversion, scanning tunneling microscope, Coulomb blockade, quantum dots, energy bands and energy gaps in solids, semiconductors, *n*-type and *p*-type semiconductors, light-emitting and light-absorbing diodes, resonant tunneling transistors, photovoltaic solar cell, junction transistor, metal-oxide-semiconductor field-effect transistor, unimolecular rectifier, carbon nanotube field emission device. Texts: *Physics for Scientists & Engineers* by R.A. Serway & J.W. Jewett; *Learning Bio-Micro-Nanotechnology* by M.I. Mendelson; *Introduction to Nanoscience & Nanotechnology* by G. Hornyak *et al*.

Foundations of Modern Physics. One semester, non-mathematical course offered as an Interdisciplinary Colloquium at Elizabethtown College. Co-taught with Michael Silberstein, Professor of Philosophy. The course introduces issues in modern physics such as quantum nonlocality, closed timelike curves, dark matter, dark energy, quantum gravity, and unification. Texts: *Seven Brief Lessons on Physics* by Carlo Rovelli; *Beyond the Dynamical Universe* by Michael Silberstein, W.M. Stuckey, and Timothy McDevitt.

Statics. One semester, sophomore-level course. Equilibria of particles and rigid bodies subject to concentrated and distributed forces with practical applications to the design of mechanical structures. Topics include: vector analysis, moments, equations of equilibrium, structural analysis, internal forces, and inertial properties. Text: *Engineering Mechanics: Statics* by R.C. Hibbler.

Modern Physics. One semester, sophomore-level course. An introduction to special relativity, general relativity and quantum mechanics. Topics include Lorentz transforms, boost matrix mechanics, Faraday tensor, Einstein's equations, relativistic cosmology and the Schwarzschild metric, dark energy and dark matter, Schrödinger's equation, reflection and transmission coefficients, the EPR paradox, and the Standard Model of particle physics. Text: *Physics for Scientists & Engineers with Modern Physics* by R.A. Serway & J.W. Jewett.

College Physics III with *Numerical Analysis Lab*. One semester, sophomore-level course. An introduction to electrostatics, magnetostatics, and partial differential equations. The laboratory covers topics such as repeated bisection and Newton's method for finding the roots of polynomials, Taylor series and the Runge-Kutta method for solving differential equations, cubic splines and least-squares fitting, and finite difference methods. Text: *Boundary Value Problems* by D.L. Powers.

Advanced Physics Laboratory for physicists and engineers. One semester, junior-level course. Advanced laboratory course with experiments in modern physics, electricity and magnetism, optics, and thermodynamics. References: *Experimental Methods for Engineers* by J.P. Holman; *Electronics and Instrumentation for Scientists* by H.V. Malmstadt, C.G. Enke, and S.R. Crouch.

Mechanics for physicists and engineers. One semester, junior-level course. An intermediate course in mechanics covering Newtonian mechanics of systems of particles, central forces, oscillations, collisions, rigid-body dynamics, and the Lagrangian formalism for generalized coordinates. Text: *Dynamics* by R.C. Hibbeler.

Electromagnetism for physicists and engineers. One semester, junior-level course. An intermediate course in vector analysis, Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Energy and Potential, Current and Capacitance, Current and Conductors, Dielectrics and Capacitance, and Poisson's and Laplace's Equations. Text: *Engineering Electromagnetics* by W.H. Hayt and J.A. Buck.

General Relativity (listed by Math Department as *Applied Differential Geometry*) for physicists and mathematicians. One semester, junior-level course. An introduction to manifolds, differential topology, exterior calculus, affine geometry, Riemannian geometry, special relativity, and general relativity with applications to relativistic cosmology and black holes. References: *Gravitation* by C.W. Misner, K.S. Thorne, and J.A. Wheeler; *General Relativity* by R.M. Wald.

Junior-Senior Colloquium titled, "Exploring Worldviews: Cosmology in Philosophical, Scientific, and Theological Perspective." One semester, junior-level course. An introduction to the central and essential cosmological questions that face all human beings, providing students with the resources and the opportunity to explore their own worldviews. Text: *God, Humanity and the Cosmos* by Christopher Southgate *et al*.

Quantum Physics I and II for physicists. One year, senior-level course. The course introduces and uses the Dirac notation to explain introductory quantum mechanics from simple one-dimensional problems through the hydrogen atom. Also studied are spin, the path integral formalism, and the addition of angular momenta. Texts: *Principles of Quantum Mechanics* by R. Shankar; *Quantum Mechanics and Experience* by David Z. Albert.

Applied Quantum Mechanics for physicists. One semester, junior-level course. In addition to texts, the course uses published papers to introduce the measurement problem, entanglement, quantum nonlocality, Bell's inequalities, principles of quantum mechanics, Hilbert spaces, Heisenberg's uncertainty principle, interaction-free measurement, quantum liar paradox, quantum eraser, weak values, Popescu-Rohrlich corrections, Tsirelson bound, no-signaling condition, and interpretations of quantum mechanics. Texts: *Quantum Mechanics and Experience* by David Z. Albert; *Totally Random: Why Nobody Understands Quantum Mechanics* by T. Bub & J. Bub.

Courses Audited at Elizabethtown College

Fundamentals of Language and Culture (GER 111)
Introduction to Music Literature (MU 105)
The Religious Literature of Early Christianity (REL 102)
Eastern Religions (REL 222)
Abstract Algebra (MA 301)
Philosophy of Natural Science (PH 370)
Christology (REL 374)
The Religious Literature of Ancient Israel (REL 101)
Philosophy of Science (PH 213)
Real Analysis I (MA 421)
Dynamic Earth (ES 111)
Topology (MA 371)
Philosophy of Mind (PH 378)
History and Philosophy of Science (PH 200)
Intermediate Mathematica (MA 170)
Foundations of Physics (PH 484)
Philosophy of Physics: Time Travel and the Nature of Space and Time (PH 374)
Numerical Methods in MATLAB (MA 460)
Philosophy and History of Physics (PH 239)