Coursework

Matthew D. Rizik

BS Pure Mathematics, 2017

- **MTH291 Mathematics Snapshots**
  Selected topics in mathematics and its applications. Emphasis will be on important and intriguing ideas in mathematics without indulging in technical details.

- **MTH254H Honors Multivariable Calculus**
  Vectors in space. Functions of several variables and partial differentiation. Multiple integrals. Line and surface integrals. Green's and Stokes's Theorems.

- **MTH310 Abstract Algebra I and Number Theory**
  Structure of the integers, congruences, rings, ring homomorphisms, ideals, quotient rings. A writing course with an emphasis on proofs.

- **MTH317H Advanced Linear Algebra**
  Systems of equations, matrix algebra, vector spaces, linear transformations, geometry of R^n, eigenvalues, eigenvectors, diagonalization, inner products. A writing course with emphasis on mathematical reasoning, proofs, and concepts.

- **MTH327H Honors Intro Analysis**
  Emphasis on foundations and metric topology. Convergence of sequence and series, continuity of functions. Differentiation and integration in one dimension.

- **MTH347H Advanced Ordinary Differential Equations**
  Separable and exact equations, linear equations and variation of parameters, higher order linear equations, Laplace Transforms, first-order linear systems, classification of singularities, nonlinear systems, partial differential equations and Fourier Series, existence and uniqueness theorems. There will be an emphasis on theory.

- **MTH429H Honors Real Analysis**
  Convergence of sequences and series of functions, differentiation and integration in higher dimensional settings. Inverse and implicit function theorems.

- **MTH418H Honors Algebra I**
  Theory of groups, Sylow theory, the structure of finite Abelian groups, ring theory, ideals, homomorphisms, and polynomial rings.

- **MTH419H Honors Algebra II**
  Algebraic field extensions, Galois theory. Classification of finite fields. Fundamental Theorem of Algebra.

- **MTH442 Partial Differential Equations**
  Classification of second order partial differential equations. Boundary and initial value problems for heat, Laplace, and wave equations in dimensions 1, 2 and 3. Variational methods and maximum principles. Separation of variables, Fourier series, Sturm-Liouville theory. Greens functions.

- **MTH496 Capstone In Mathematics**
  Law of large numbers, central limit theorem, conditioning, filtrations, martingales, Markov chains, Wiener process, stochastic differential equations, Ito and Stratonovich integration.

- **MTH828 Real Analysis I**, *audited*
  Lebesgue measure on real line, general measure theory. Convergence theorems, Lusin's theorem, Egorov's theorem, Lp-spaces, Fubini's theorem. Functions of bounded variation, absolutely continuous functions, Lebesgue differentiation theorem.

- **MTH829 Complex Analysis I**, *audited*
  Cauchy theorem, identity principle, Liouville's theorem, maximum modulus theorem. Cauchy formula, residue theorem, Rouche's theorem. Casorati-Weierstrass theorem, Arzela-Ascoli theorem. Conformal mapping, Schwarz lemma, Riemann mapping theorem.

BS Physics, 2017

- **PHY192 Physics Lab for Scientists II**
  Electric and magnetic fields, circuits, wave optics, modern physics.
- **PHY215 Thermodynamics and Modern Physics**
  Thermodynamics, atomic physics, quantized systems, nuclear physics, solids, elementary particles.
- **PHY321 Classical Mechanics I**
  Newtonian point particles. Oscillations. One-particle chaos. Central-force motion. Systems of particles.
- **PHY405 Directed Studies**
  Guided independent study of special topics (low-order QED with Dr. Daniel Stump).
- **PHY410 Thermal and Statistical Physics**
  Equilibrium statistical mechanics and thermodynamics, kinetic theory, phase transformations.
- **PHY440 Electronics**
  Concepts of electronics used in investigating physical phenomena. Circuits, amplifiers, diodes, LEDs, transistors.
- **PHY451 Advanced Laboratory**
  General research techniques, design of experiments, and the analysis of results based on some historical experiments in modern physics.
- **PHY471 Quantum Physics I**
  Schroedinger equation, hydrogen atom, harmonic oscillator, and other one-dimensional systems.
- **PHY472 Quantum Physics II**
  Matrix formulation of quantum mechanics, perturbation theory, scattering.
- **PHY481 Electricity and Magnetism I**
  Electrostatics, dielectrics, magnetic fields of steady state currents, Faraday law of induction.
- **PHY482 Electricity and Magnetism II**
  Maxwell's equations, scalar and vector potentials, electromagnetic plane waves.
- **PHY491 Atomic, Molecular, and Condensed Matter Physics**
  Many-electron atoms. Molecules, crystal structure, lattice dynamics. Band models of metals and semiconductors. Transport properties.
- **PHY802 Survey of Nuclear Physics**
  Survey of phenomena and conceptual foundations of nuclear physics.
- **PHY803 Survey of Elementary Particle Physics**
  Overview of high-energy physics, including the standard model, quark composition of hadrons, collider physics and the role of elementary particle physics in cosmology.
- **PHY812 Advanced Methods of Theoretical Physics**
  Advanced mathematical tools for theoretical physics. Group theory, advanced Green's functions and asymptotic methods.
- **PHY820 Classical Mechanics**
  Two-body central force problem, Hamilton's principle, Lagrangian and Hamiltonian equations of motion, variational methods, small oscillations, classical fields.
- **PHY831 Statistical Mechanics**
  Equilibrium statistical mechanics and thermodynamics. Boltzmann transport equations and hydrodynamics. Brownian and Langevin motion.
- **PHY841 Classical Electrodynamics I**
  Electrostatics, magnetostatics, time-varying fields and Maxwell's equations. Gauge transformations. Poynting's theorem and conservation laws.
- **PHY851 Quantum Mechanics I**
  Axioms of quantum and wave mechanics, applications to spherically symmetric potentials. Hydrogen atom, harmonic oscillator, matrix mechanics, angular momentum theory, rotations.

- **PHY852 Quantum Mechanics II**
  Approximation methods, perturbation theory, atomic physics applications, scattering theory, identical particles, Pauli principle, Bose and Einstein statistics, Hartree-Fock approximation, collisions of identical particles, radiation.
- **PHY855 Quantum Field Theory**
  Introduction to field theory as it pertains to numerous problems in particle, nuclear and condensed matter physics. Second quantization, applications to different fields based on perturbation theory. Offered first half of semester.
- **PHY951 Concepts and Calculations for the Standard Model**
  Concepts, phenomena and calculations the standard model for particle physics
- **PHY955 Relativistic Quantum Field Theory**
  Theory of relativistic quantum fields and renormalization with emphasis on applications for particle physics. Offered second half of semester.
- **AST207 The Science of Astronomy**
  In-depth study of one topic in astronomy with emphasis on key discoveries. Topics may be cosmology, the solar system, and the life of stars.
- **AST208 Planets and Telescopes**, *audited*
  Origin and nature of the solar system. Planets of the solar system and other star systems. Determination of time and celestial coordinates. Astronomical instruments and observational methods.
- **AST304 Stars**, *audited*
  Physical processes that determine the structure and evolution of stars. Observations of stars and star clusters. Spectra of stars.
- **AST308 Galaxies and Cosmology**, *audited*
  The Milky Way. Structure and content of galaxies. Active galaxies and quasars. The expanding universe. Modern cosmological models.
- **AST860 Gravitational Astrophysics**
  Experimental foundations, theory, and applications of gravitational physics and general relativity. Tests of the equivalence principle, modern solar system tests of general relativity, Schwarzschild metric, Hawking effect, Einstein's field equations.

Ph.D. Physics - High Energy Theory, 2023

- **PHY842 Classical Electrodynamics II**
  Plane electromagnetic waves, polarization states, reflection, refraction. Wave guides and resonant cavities. Radiating systems, dipole fields, radiated power. Special theory of relativity.
- **PHY956 Collider Phenomenology**
  Theory and phenomenology of high-energy collider physics. Quantum chromodynamics evolution, structure functions and higher-order calculations.
- **PHY959 Special Topics in High-Energy Physics**
  Beyond the Standard Model
- **PHY989 Special Topics in Nuclear Physics**
  Advanced Quantum Field Theory and lattice QCD.
- **PHY989 Special Topics in Nuclear Physics**
  Renormalization Group and Statistical Physics.
- **MTH880 Combinatorics**
  Enumerative combinatorics, recurrence relations, generating functions, asymptotics, applications to graphs, partially ordered sets, generalized Moebius inversions, combinatorial algorithms.
- **MTH868 Geometry and Topology I**
  Fundamental group and covering spaces, van Kampen's theorem. Homology theory, Differentiable manifolds, vector bundles, transversality, calculus on manifolds. Differential forms, tensor bundles, deRham theorem, Frobenius theorem.

- **MTH869 Geometry and Topology II**
  Algebraic geometry, continuation of MTH 868.
- **MTH916 Algebraic Geometry**, *audited*
  Affine and projective algebraic varieties and their properties. Morphisms and singularities. Schemes and coherent sheaves. Sheaf cohomology and other related topics.
- **MTH960 Algebraic Topology I**, *audited*
  Cohomology, products, duality, basic homotopy theory, bundles, obstruction theory, spectral sequences, characteristic classes, and other related topics.
- **MTH993 Special Topics in Geometry**
  Symplectic Topology and J-Holomorphic Curves.