# Brock University Course List

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# Introduction

This is a list courses I have taken throughout my tenure at Brock University. The courses are sorted by subject. The course codes are listed with the first number referring to the year of study (1PXX refers to first year). I am a physics and mathematics major but I have taken a variety of other courses. The five subjects I have divided them into is physics, mathematics, economics, philosophy, and miscellaneous.

# Physics

- **Introductory Physics I with Laboratory (PHYS 1P91)**: Kinematics, Newton's laws and their applications to equilibrium and dynamics; conservation laws; oscillations, waves and sound.
- **Introductory Physics II with Laboratory (PHYS 1P92)**: Charges and fields; electric currents and circuits, electromagnetic waves and wave nature of light, elements of modern physics.
- **Introductory Physics III with Laboratory (PHYS 1P93)**: Fluids in equilibrium, surface tension and capillary action; fluids in motion, viscosity and turbulent flow. Heat and temperature, elements of kinetic theory and the laws of thermodynamics. Geometrical optics, waves and sound.
- **Introduction to Medical Physics (PHYS 2P02)**: Physical and chemical interactions of ionizing radiations and their biological effects, structural imaging (magnetic resonance imaging, ultrasound, computed tomography and optical microscopy); nuclear medicine, therapeutic applications of radiation.
- **Introductory Mechanics (PHYS 2P20)**:Mechanics of particles and systems of particles by the Newtonian method; conservation of linear momentum, angular momentum and energy; elementary dynamics of rigid bodies; oscillators; motion under central forces; selected applications.
- **Introduction to Electronics, with Laboratory (PHYS 2P31)**: Basic physical concepts; DC circuits; Transient currents; Sinusoidal currents, simple AC circuits; Non-linear circuit elements; Operational amplifiers.
- **Modern Physics (PHYS 2P50)**: Special Relativity; Quantum Theory of Light; Wave Nature of Matter; Quantum Mechanics.
- **Introduction to Classical and Modern Optics (PHYS 2P51)**: Geometrical Optics; Reflection, Refraction, Lenses, Mirrors, Stops and Pupils, Fiber Optics, Ray Tracing, Wave Optics; Interference, Coherence, Diffraction, Polarization, Holography
- **Electromagnetism I (PHYS 3P35)**: Electric Field, divergence and curl of electrostatic field; relation between electric work and energy; conductors; applications of Laplace's and Poisson's equation in electrostatics; electrostatic fields in matter; field in polarized object and linear dielectrics.
- **Statistical Physics I (PHYS 3P41)**: Introduction to probability distribution functions, accessible states, entropy, temperature, partition functions and relations to thermodynamic functions.
- **Introduction to Quantum Mechanics (PHYS 3P70)**: Wave particle dualism, Schrodinger equation, solution of simple one-dimensional barrier problems and the harmonic oscillator, hydrogen atom, angular momentum theory, introduction to perturbation theory and variational methods.
- **Classical Mechanics (PHYS 3P90)**: Advanced treatment of the mechanics of particles and of rigid bodies; Lagrangian and Hamiltonian methods; Poisson brackets, applications to the theory of small oscillators and central force motions, elements of chaotic motions.

- **Experimental Physics I (PHYS 3P91)**: X-ray fluorescence, X-ray powder diffraction, Electron diffraction, Preparation of a thin film of Bismuth, Resistivity and Hall effect measurements on a thin film of Bismuth, Gamma-ray scintillation spectroscopy and the Compton effect, Planck's constant measurement I (black-body radiation), Planck's constant measurement II (photoelectric effect), Raman spectroscopy.
- **Introduction to Mathematical Physics (PHYS 3P95)**: Calculus of variations, least action principle in physics, symmetries and conservation laws, differential-geometric structures (differential form, vector field, Riemannianmetric). Applications to physics: electro-magnetic field as a one-form, gravity as a pseudo-Riemannian metric. Introduction to mathematical ideas of quantum mechanics.
- **Solitons & Nonlinear Wave Equations (PHYS 4P09)**: Linear and nonlinear travelling waves. Nonlinear evolution equations (Korteweg de Vries, nonlinear Schrodinger, sine-Gordon). Soliton solutions and their interaction properties. Lax pairs, inverse scattering, zero-curvature equations and Backlund transformations, Hamiltonian structures, and conservation laws.
- **Quantum Mechanics (PHYS 4P51)**: Postulates about states, observables, probabilities, change of state in a measurement, and time evolution. Dirac's bra and ket notation; representation and transformation theory. Two-level systems. Complete set of commuting observables and classification of states. Symmetries and their usage in classification of states.
- **Nuclear Physics (PHYS 4P61)**: Intrinsic properties of nuclei, nuclear binding energy; qualitative treatment of shell model; alpha, beta and gamma radioactivities, nuclear fission, characteristics of nuclear reactions.
- **Research Project (PHYS 4F90)**: Small experimental, theoretical or applied physics research project to be carried out under the supervision of a member of the department.

# Mathematics

- **Applied Calculus I (MATH 1P05)**: Differential calculus emphasizing problem solving, calculation and applications. Pre-calculus topics, limits, continuity, derivatives and differentiability, implicit differentiation, linear approximation, maximum and minimum, related rates, curve sketching, l'Hospital's rule, antiderivatives,integrals, Fundamental Theorem of Calculus without proof, integration by substitution. Use of Maple.
- **Applied Calculus II (MATH 1P06)**: Integral calculus emphasizing problem solving, calculations and applications. Further techniques of integration. Areas between curves, volumes, arc length and probabilities. 1st order differential equations. Sequences and series: convergence tests, Taylor and Maclaurin series and applications. Use of computer algebra system.
- **Linear Algebra I (MATH 1P11)**: Review of linear systems and matrix algebra. General determinants and applications.Complex numbers. Vector geometry in $R^2$ and $R^3$. Dot product, norm and projections,cross product, lines and planes. Finite-dimensional vector spaces (real and complex).Linear transformations; rank and kernels. Eigenvalues.
- **Mathematics Integrated with Computers and Applications I (MATH 1P40)**: Exploration of ideas and problems in algebra, differential equations, and dynamical systems using computers. Topics include number theory, integers mod p, roots of equations, fractals, predator-prey models and the discrete logistic equation for population growth.
- **Mathematics Integrated with Computers and Applications II (MATH 2P40)**: Theory and applications of mathematical modelling and simulation. Topics may include discrete dynamical systems, Monte-Carlo methods, stochastic models, the stock market, epidemics, analysis of DNA, chaotic dynamical systems, cellular automata and predator-prey.

- **Practical Statistics (MATH 1P98)**: Descriptive statistics; probability of events; counting rules; discrete and continuous probability distributions: binomial, Poisson and normal distributions; Central Limit Theorem; confidence intervals and hypothesis testing; analysis of variance; contingency tables; correlation and regression; emphasis on real-world applications throughout; use of statistical computer software.
- **Multivariable Calculus (MATH 2P03)**: Functions of two and three variables, partial derivatives, gradient, critical points, maxima and minima, Taylor expansion, inverse and implicit function theorems. Cartesian, polar, cylindrical and spherical coordinates. Curves and surfaces, parametric representation, tangent space. Two- and three-dimensional integration, line and surface integrals.
- **Ordinary Differential Equations (MATH 2P08)**: Linear and nonlinear differential equations. Basic existence and uniqueness theory.Analytical and numerical solution methods; asymptotic behaviour. Qualitative analysis of autonomous systems including periodic cycles and steady-states. Examples of conservative systems and dissipative systems. Modelling and applications of differential equations. Use of Maple.
- **Linear Algebra II (MATH 2P12)**: Finite dimensional real vector spaces and inner product spaces; matrix and linear transformations; eigenvalues and eigenvectors; the characteristic equation and roots of polynomials; diagonalization; complex vector spaces and inner product spaces; selected applications.
- **Probability (MATH 2P81)**: Probability, events, algebra of sets, independence, conditional probability, Bayes' theorem; random variables and their univariate, multivariate, marginal and conditional distributions. Expected value of a random variable, the mean, variance and higher moments, moment generating function, Chebyshev's theorem. Some common discrete and continuous distributions: Binomial, Poisson, hypergeometric, normal, uniform and exponential. Use of SAS, Maple or other statistical packages.
- **Probability II (MATH 2P82)**: Random sampling, descriptive statistics, Central Limit Theorem, sampling distributions related to normality; point estimation: measurements for estimation performance, methods of moments, maximum likelihood, ordinary/weighted least squares; confidence intervals, testing procedures, and their relation for population means, difference between means, variances, ratio of variances, proportions and difference between proportions.
- **Complex Analysis (MATH 3P04)**: Algebra and geometry of complex numbers, complex functions and their derivatives; analytic functions; harmonic functions; complex exponential and trigonometric functions and their inverses; contour integration; Cauchy's theorem and its consequences; Taylor and Laurent series; residue.
- **Vector Calculus and Differential Geometry (MATH 3P06)**: Vector fields, vector algebra, vector calculus; gradient, curl and divergence. Polar, cylindrical and spherical coordinates. Green's, Stokes' and divergence theorems. Introduction to differential geometry of surfaces. Topics may include differential forms, exterior calculus, frames, Gauss-Bonnet theorem.
- **Advanced Differential Equations (MATH 3P08)**: Linear second-order differential equations and special functions. Introduction to Sturm-Liouville theory and series expansions by orthogonal functions. Boundary value problems for the heat equation, wave equation and Laplace equation. Green's functions. Emphasis on applications to physical sciences. Use of Maple.
- **Partial Differential Equations (MATH 3P09)**: Survey of linear and nonlinear partial differential equations. Analytical solution methods. Existence and uniqueness theorems, variational principles, symmetries, and conservation laws. Emphasis on applications to physical sciences. Use of Maple.

# Economics

- **Principles of Microeconomics (ECON 1P91)**: Introduction to microeconomics. Topics include nature of economics, price system, demand, production and cost, markets and pricing, factor pricing

and distribution of income.

- **Principles of Macroeconomics (ECON 1P91)**: Introduction to macroeconomics. Topics include nature of economics, determination and control of national income, money, banking and monetary policy, macroeconomic policy and balance of payments.
- **Intermediate Microeconomics I (ECON 2P21)**: Topics include the theory of the consumer and producer, willingness to pay, index numbers, the structure of a perfectly competitive industry and an introduction to imperfectly competitive markets. Applications are emphasized.
- **Intermediate Macroeconomics I (ECON 2P22)**: Main determinants of aggregate output and national income in an open economy. Topics include money and interest, effects of fiscal and monetary policies, and trade and capital flows under different exchange rate regimes. Extension of the macroeconomic model to include the price level. Study of aggregate demand and aggregate supply.
- **Economics of Illicit Drugs (ECON 2P34)**: Economic analysis of illicit drugs, Including effects on demand, supply, prices and other market outcomes. Market structure, drug pricing, and price discrimination in comparison to the legal drug market. Public policy issues such as legalization, costs of addiction, enforcement and punishment.
- **Economics of Professional Sports (ECON 2P42)**: Economics of professional sport industries. Topics include the cost and market structures of professional sport, government subsidies for stadiums and arenas, team objectives, competitive balance and revenue sharing, player salaries and labour markets, and introduction to sports analytics.
- **Introduction to Econometrics (ECON 2P90)**: Probability, random variables and density functions; correlation analysis; estimation and hypothesis testing in the classical linear regression model. Practical applications to different areas of economics and business.

# Philosophy

- **Growth of Greek Philosophy: Aristotle and Beyond (PHIL 2P01)**: Survey of Western philosophy from Aristotle, the Hellenistic schools (Epicurean, Stoic, Sceptic) to Plotinus (third century AD)
- **The Growth of Existential Thinking (PHIL 2P15)**: The work of such philosophers as Heidegger, Sartre and Camus

# Miscellaneous

- **Hip Hop and the Urban Working Class (LABR 2P91)**: Global urban working class life through the lens of hip hop culture. Topics may include the impact of neoliberal globalization, precarious work, the informal economy, and the ways in which race, class and gender shape experiences of social and economic life in the global city.
- **An Introduction to Language (LING 1F25)**: Readings and discussion regarding language study past and present, including the study of language and its relation to thought. Form, meaning, and use of language as examined variously from one time and place to another. Role of language study in the discussion of a range of social phenomena and issues