ENGINEERING PHYSICS

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Core courses in the Engineering Physics plan provide the student with fundamental physical principles and theoretical tools for professional practice as well as a firm foundation in modern experimental techniques. To relate these abilities to the attitudes and knowledge of other engineering disciplines, the plan has four sub-plans: electrical, materials, mechanical, and computing. These sub-plans provide a sequence of courses in other engineering departments and thus provide career or graduate studies opportunities in both engineering and applied physics.

Note: **Students will not be registered in any core second year engineering physics courses until they have passed all the required first year mathematics and physics courses. It is strongly recommended that students have a grade of C- or better in the first year mathematics and physics courses.**

Fourth year elective courses must be chosen such that at the end of the academic plan each student meets or exceeds the Canadian Engineering Accreditation Board (CEAB) program requirements. A spreadsheet will be provided by the Undergraduate Chair to aid fourth year students with their course selection.
Options available:

- Electrical Option
- Materials Option
- Mechanical Option
- Computing Option

- Engineering Physics, B.A.Sc. (Class of 2022) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/engineering-physics/engineering-physics-basc-class-2022/)
- Engineering Physics, B.A.Sc. (Class of 2023) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/engineering-physics/engineering-physics-basc-class-2023/)
- Engineering Physics, B.A.Sc. (Class of 2024) (https://queensu-ca-public.courseleaf.com/engineering-applied-sciences/academic-plans/engineering-physics/engineering-physics-basc-class-2024/)

Courses

ENPH 211 Applied Physics Units: 3.50
This course stresses the creation of physical models for real systems. Applications of vibrational motion are developed and a basic description of the properties of elastic media given. The methods required to predict the performance of physical or engineering systems are demonstrated using examples drawn from various fields of science and engineering with emphasis on mechanics and vibrations, waves and optics.
Requirements: ENPH 225
Offering Faculty: Faculty of Arts and Science

ENPH 213 Computational Eng. Physics Units: 4.00
Introduction to the use of numerical methods in solving physics and engineering problems. A high-level language appropriate for engineering, such as Python, will be introduced and used throughout the course. Possible topics to be covered include numerical differentiation and integration (with applications in error propagation), root finding and optimization problems (including curve fitting), solution of linear systems of equations, finite-element modelling, fast Fourier transforms and Monte Carlo simulations.
Requirements: APSC 143 and MTHE 227 or MATH
Offering Faculty: Faculty of Arts and Science

ENPH 225 Mechanics Units: 3.50
Extension of classical mechanics and engineering applications. Plane dynamics,
relative motion and forces in moving and accelerated reference frames. Introduction to general three-dimensional motion of a rigid body, inertia tensor and steady-state precession. The laws of conservation of mass, momentum and energy.
Requirements: Prerequisite of APSC111 and APSC112 and APSC171 and APSC172 and APSC174 and registered in a BSCE or BASC Academic Program.
Offering Faculty: Faculty of Arts and Science

ENPH 239 Eng. Electricity & Magnetism Units: 3.50
The experimental basis and mathematical description of electrostatics, magnetostatics and electromagnetic induction, together with a discussion of the properties of dielectrics and ferromagnetics, are presented. Both the integral and vector forms of Maxwell's equations are deduced.
Requirements: MTHE 227 OR MATH 227 OR MTHE
Offering Faculty: Faculty of Arts and Science

ENPH 242 Relativity And Quanta Units: 3.50
Evidence for relativistic effects. Kinematics and dynamics in special relativity, space-time diagrams, applications. Evidence for quanta, spectra, Bohr atom. Introduction to the Schroedinger equation.
Requirements: APSC 111 and APSC 112
Offering Faculty: Faculty of Arts and Science

ENPH 251 Engineering Phys Lab And Stats Units: 4.25
The demonstration of the basic techniques of the engineering physicist in the measurement of electric, magnetic, thermal and mechanical properties. The emphasis is on correct measurement techniques, treatment of results and the presentation of data. Error and uncertainties in experimental measurement, the propagation of errors. Probability and the Binomial, Poisson and Gaussian distribution functions, fitting of Poisson and Gaussian distributions to a sample population. Linear least squares fit, chi-squared.
Requirements: ENPH 225 and ENPH 231 and ENPH
Offering Faculty: Faculty of Arts and Science

ENPH 252 Mangmt Of Experimental Data Units: 1.25
Error and uncertainties in experimental measurement, the propagation of errors. Probability and the Binomial, Poisson and Gaussian distribution functions, fitting of Poisson and Gaussian distributions to a sample population. Linear least-squares fitting, chi-squared. The graphical treatment and presentation of data; regression and power law analyses.
Requirements: Must be registered in a BSCE or BASC Academic Program.
Offering Faculty: Faculty of Arts and Science

ENPH 253 Engineering Physics Laboratory Units: 3.50
The demonstration of the basic techniques of the engineering physicist in the measurement of electric, magnetic and mechanical properties. The emphasis is on correct measurement techniques, error analysis, treatment of results and the presentation of data.
Requirements: Prereq: ENPH 252 (PHYS 252) Coreq: ENPH 211, ENPH225
Offering Faculty: Faculty of Arts and Science

ENPH 316 Mathematical Methods in Physics I Units: 3.50
Methods of mathematics important for physicists. Complex arithmetic, series expansions and approximations of functions, Fourier series and transforms, vector spaces and eigenvalue problems, and differential equations.
Requirements: Prerequisite: MTHE 227 (MATH 221 or MATH 280), MTHE 237 (MATH 225 or MATH 231) Exclusions: ENPH 312 (PHYS 312), MTHE 338 (MATH 338), MTHE 334 (MATH 334), MTHE 335 (MATH 335)
Offering Faculty: Faculty of Arts and Science

ENPH 317 Mathematical Methods in Physics II Units: 3.50
A continuation of PHYS 316. Partial differential equations, functions of a complex variable and contour integration, and special topics such as probability and statistics, group theory and non-linear dynamics.
Requirements: Prerequisite: ENPH 316 (PHYS 316). Exclusions: ENPH 312 (PHYS 312), MTHE 338 (MATH 338), MTHE 334 (MATH 334), MTHE 335 (MATH 335) Must be in a BSCE or BASC program.
Offering Faculty: Faculty of Arts and Science

ENPH 321 Advanced Mechanics Units: 3.50
An introduction to the equations of mechanics using the Lagrange formalism and to the calculus of variations leading to Hamilton's principle. The concepts developed in this course are applied to problems ranging from purely theoretical constructs to practical applications. Links to quantum mechanics and extensions to continuous systems are developed.
Requirements: ENPH 211 or PHYS 211 and MATH
Offering Faculty: Faculty of Arts and Science

ENPH 332 Electromagnetic Theory Units: 3.50
An introduction to electromagnetic theory and some of its applications. Topics are: Maxwell's equations, properties of waves in free space, dielectrics, conductors and ionized media, reflection and refraction at the surfaces of various media, radiation of electromagnetic waves, antennae, wave-guides, and optical fibers.
Requirements: ENPH 231or PHYS 235 or ELEC 28
Course Equivalencies: PHYS332, PHYS432
Offering Faculty: Faculty of Arts and Science

ENPH 334 Electronics For Applied Scient Units: 5.00
The design of electronic circuits and systems, using commonly available devices and integrated circuits. The properties of linear circuits are discussed with particular reference to the applications of feedback; operational amplifiers are introduced as fundamental building blocks. Digital circuits are examined and the properties of the commonly available I.C. types are studied; their use in measurement, control and signal analysis is outlined. Laboratory work is closely linked with lectures and provides practical experience in the subjects covered in lectures.
Requirements: ENPH 239 or PHYS 231 or ELEC 2
Offering Faculty: Faculty of Arts and Science

ENPH 335 Semiconductor Physics Units: 4.00
An examination of the basic phenomena of semiconductor physics and their application in diodes, transistors, optical detectors, and lasers. The laboratory illustrates the use of semiconductor devices in electronic circuits. (0/10/2/28/8)~ COURSE DELETED IN 2008/09 ~
Requirements: PHYS231 OR PHYS235 OR PHYS239
Offering Faculty: Faculty of Arts and Science

ENPH 336 Solid State Devices Units: 3.25
This course deals with the fundamental concepts of solid state materials and the principles of operation of modern electronic and optoelectronic devices. Topics in materials include crystal structure, energy bands, carrier processes and junctions. Topics in device operation include p-n junction diodes, bipolar junction transistors, field-effect junction transistors, metal-oxide-semiconductor field-effect transistors, and optoelectronic devices.
Requirements: PREREQUISITES: ELEC 252, ELEC 280 or ENPH 239 (PHYS 239). Must be registered in a BSCE or BASC Academic Program. EXCLUSION: PHYS 335
Offering Faculty: Faculty of Arts and Science

ENPH 342 Relativity And Quanta Units: 3.25
Evidence for relativistic effects. Kinematics and dynamics in special relativity, Minkowski diagram, applications. Evidence for quanta, spectra, Bohr atom, quantum statistics. Descriptive nuclear physics, radioactivity, elementary particles. (5/30/0/4/0) ~ COURSE DELETED IN 2008/09 ~
Requirements: (PHYS113 AND PHYS114) OR (APSC111 AND APSC112)
Offering Faculty: Faculty of Arts and Science

ENPH 343 Wave Mechanics Units: 3.00
Wave description of matter. Schrodinger equation, angular momentum, tunneling. Application to atomic structure, spectra, the electron gas and quantum systems. (4/28/0/4/0)~ COURSE DELETED IN 2008/09 ~
Requirements: (PHYS211 AND PHYS342) OR (PHYS211 AND MATH227) OR (PHYS211 AND MATH226) OR (PHYS211 AND PHYS342) OR (PHYS211 AND MATH237) OR (PHYS211 AND MATH227) OR (PHYS212 AND PHYS242) OR (PHYS212 AND MATH231) OR (PHYS212 AND MATH221) OR (PHYS212 AND MATH227) OR (PHYS212 AND PHYS242) OR (PHYS212 AND MATH231) OR (PHYS212 AND PHYS242) OR (PHYS212 AND MATH231) OR (PHYS212 AND MATH280) OR (PHYS212 AND PHYS242) OR (PHYS212 AND MATH232) OR (PHYS212 AND MATH221) OR (PHYS212 AND MATH232) OR (PHYS212 AND PHYS242) OR (PHYS212 AND MATH227) OR (PHYS212 AND MATH232) OR (PHYS212 AND MATH280) OR (PHYS212 AND PHYS242)
Course Equivalencies: PHYS343, PHYS344
Offering Faculty: Faculty of Arts and Science

ENPH 344 Intro. To Quantum Mechanics Units: 3.50
Matter waves. Postulates of wave mechanics. Stationary states and one-dimensional potentials. Particle tunnelling and scattering states. Introduction to matrix mechanics and Dirac notation. Quantized angular momentum, and the H atom.
Requirements: MTHE 237 (MATH 225 or MATH 231 or MATH 232), MTHE 227 (MATH 221 or MATH 280), ENPH 242 (PHYS 242), ENPH 211 (PHYS 212)
Offering Faculty: Faculty of Arts and Science

ENPH 345 Quantum Physics Of Atoms Units: 3.50
Spin. Addition of angular momentum. Many electron atoms and the periodic table. Introduction to perturbation theory and Fermi's golden rule. Time dependent perturbations, including stimulated emission. Introduction to nuclear and particle physics.
Requirements: PREREQ: ENPH 344 (PHYS 344) and registered in a BSCE or BASC Academic Program.
Offering Faculty: Faculty of Arts and Science

ENPH 353 Engineering Physics Experiment Design Units: 2.50
A course on the design of advanced physics experiments. Students learn advanced measurement techniques in the context of modern physics experiments, including nanoscience, quantum physics, optics and particle physics. The lectures cover probability and the statistical interpretation of data, methods of measurement, and how to design an experiment. Students spend the majority of the term on an experimental project of their choosing, researching, assembling, carrying out the experiment, analyzing and presenting the results.
Requirements: ENPH 251 or 253
Offering Faculty: Faculty of Arts and Science

ENPH 354 Engineering Physics Design Project Units: 3.50
Students will apply technical knowledge, models, and computer-aided design tools to solve an open-ended design problem. The students will work in teams to design, built, and test a prototype device. The lectures provide background on the physics and engineering of the device and introduce the design tools and techniques that will be required to complete the project.
Requirements: APSC 200, 293, ENPH 253 OR 251
Offering Faculty: Faculty of Arts and Science

ENPH 372 Thermodynamics Units: 3.50
Temperature, equations of state, internal energy, first and second laws, entropy and response functions. Application to heat engines and refrigerators. Free energies, Legendre transformations, changes of phase. Introduction to the Boltzmann factor and statistical mechanics.
Requirements: ENPH (PHYS) 242
Offering Faculty: Faculty of Arts and Science

ENPH 414 Introducation to General Relativity Units: 3.00
Einstein's theory of gravity is developed from fundamental principles to a level which enables the student to read some of the current literature. Includes an introduction to computer algebra, an essential element of a modern introduction to Einstein's theory.
Requirements: ENPH 321 (or PHYS 321) ENPH
Offering Faculty: Faculty of Arts and Science

ENPH 424 Quantum Mechanics I Units: 3.00
The mathematical and physical foundations of quantum theory are formulated. The basic principles are illustrated by applications in atomic, molecular, nuclear and solid state physics. (4/20/0/12/0)~ COURSE DELETED 2009/10) ~
Requirements: PHYS343 OR CHEM331 OR CHEM313
Course Equivalencies: PHYS345, PHYS424
Offering Faculty: Faculty of Arts and Science

ENPH 426 Quantum Mechanics II Units: 3.00
A continuation of quantum theory at a more advanced level. Topics include time-dependent perturbation theory, scattering theory and the quantum theory of many-particle systems. (0/36/0/0/0)~ COURSE DELETED IN 2009/10 ~
Requirements: PHYS424
Course Equivalencies: PHYS426, PHYS444
Offering Faculty: Faculty of Arts and Science

ENPH 431 Electromagnetic Theory Units: 3.50
An introduction to electromagnetic theory and some of its applications. Topics are: Maxwell's equations, properties of waves in free space, dielectrics, conductors and ionized media, reflection and refraction at the surfaces of various media, radiation of electromagnetic waves, antennae, wave-guides, and optical fibers.
Requirements: PREREQUISITES: MTHE 226 (MATH 226) or MTHE 235 (MATH 235) or MTHE 237 (MATH 237), MTHE 227 (MATH 227), ENPH 239 (PHYS 239) EXCLUSIONS: ENPH 332 (PHYS 332), PHYS 432
Offering Faculty: Faculty of Arts and Science

ENPH 444 Advanced Quantum Physics Units: 3.00
This course covers perturbation theory, scattering theory and the addition of angular momentum. Special topics may include: many-electron systems, path integral formulation of quantum mechanics, entanglement and quantum computing, quantum optics.
Requirements: ENPH 345 or PHYS 345
Offering Faculty: Faculty of Arts and Science

ENPH 453 Advanced Physics Laboratory Units: 3.50
This course provides students in Engineering Physics with experience in a range of advanced experimental techniques and analysis. A balanced selection of experiments are performed from fields including nuclear physics, applied physics, solid state physics, low temperature physics, and optics.
Requirements: PHYS 350 or ENPH 351 or PHYS 3
Offering Faculty: Faculty of Arts and Science

ENPH 454 Advanced Engineering Physics Design Project Units: 4.50
This course provides engineering physics students with a complete experience in advanced design and implementation. Working in groups, students undertake a large design project of their choice that reflects and further develops their knowledge of physics and engineering design. The students then build a prototype of their design to demonstrate the feasibility of project within the design constraints.
Requirements: ENPH 354
Offering Faculty: Fac of Engineering Appl Sci

ENPH 455 Engineering Physics Thesis Units: 4.00
Students will be assigned individual design topics of the type a practicing engineering physicist might expect to encounter. They must develop a solution under the supervision of a faculty member, and give oral and written presentations to an examining committee. Grades will be based on the quality of the analysis of the problem, the proposed solution, and the written and oral presentations. The demonstration of effective written and oral communications skills is required.
Requirements: PHYS 351 OR ENPH 354
Offering Faculty: Faculty of Arts and Science

ENPH 456 Advanced Engineering Physics Thesis I: Units: 2.00
Students will be assigned individual research topics. Students must work under the supervision of a faculty member. Grade will be based on the progress in arriving at a solution to the assigned problem.
Offering Faculty: Faculty of Arts and Science

ENPH 457 Advanced Engineering Physics Thesis II Units: 9.00
Continuation of ENPH 456. Upon completion of their thesis, students must give oral and written presentations to an examining committee. Grades will be based on the quality of the analysis of the problem, the proposed solution, and written and oral presentations. Demonstration of effective written and oral communications skills is required.
Requirements: ENPH457 Req Exclusios
Offering Faculty: Faculty of Arts and Science

ENPH 460 Laser Optics Units: 3.50
Topics and applications in modern physical optics, culminating with the development of the laser and its current applications. Topics include: Gaussian beam propagation, optical resonators, Fourier optics, fiber optics, holography, light-matter interaction using classical and semi-classical models, and the basic theory and types of lasers.
Requirements: ENPH 239 and ENPH 344 or PHYS
Offering Faculty: Faculty of Arts and Science

ENPH 472 Statistical Mechanics Units: 3.50
Phase space, the ergodic hypothesis and ensemble theory. Canonical and grand canonical ensembles. Partition functions. Ideal quantum gases. Classical gases and the liquid vapour transition. Introduction to techniques for interacting systems, including Monte Carlo simulations.
Requirements: PREREQUISITES: ENPH 213 and ENPH 372 EXCLUSION: ENCH 412
Offering Faculty: Faculty of Arts and Science

ENPH 479 High Performance Computational Physics Units: 3.00
A course to teach students how to use the tools of high performance computing facilities, and to have them employ these tools and various common numerical algorithms in the solution of numerical physics projects.
Offering Faculty: Faculty of Arts and Science

ENPH 480 Solid State Physics Units: 3.50
An introduction to the properties of insulators, semiconductors and metals. Topics include: crystal structure, X-ray and neutron scattering, the reciprocal lattice, phonons, electronic energy bands, and the thermal, magnetic, optical and transport properties of solids.
Requirements: ENPH 380 and ENPH 345 or permi
Offering Faculty: Faculty of Arts and Science

ENPH 481 Solid State Device Physics Units: 3.50
A course in the physics underlying solid state electronic and optical devices. The course presents an introduction to the electrical and optical properties of insulators, semiconductors and metals, including crystal structure, band theory, and electron transport. This is applied to obtain a physical understanding of the physics governing the behaviour of diodes, field effect and bipolar transistors, and other discrete optical and electronic devices.
Requirements: ENPH (or PHYS 231), ENPH 344
Offering Faculty: Faculty of Arts and Science

ENPH 483 Nanoscience & Nanotechnology Units: 3.50
An examination of the key ideas, techniques and technologies in the fields of nanoscience and nanotechnology. Emphasis will be placed on the physics involved, measurement techniques, and technological applications. Topics covered are selected from the following: electrical and optical properties of quantum dots, quantum wires and nanotubes; quantum information technology; mesoscopic electronics; nanostructures on surfaces; and scanning-probe and optical microscopy.
Requirements: ENPH 344 or PHYS 344 and ENPH
Offering Faculty: Faculty of Arts and Science

ENPH 490 Nuclear And Particle Physics Units: 3.50
A systematic introduction to nuclear and particle physics for advanced physics students. Topics include basic nuclear properties: size, mass, decay and reactions; shell model of nuclear structure; magnetic moments; gamma and beta decay; quark model of elementary particles; and strong, electromagnetic and weak interactions.
Requirements: ENPH 345 or PHYS 345 and regis
Offering Faculty: Faculty of Arts and Science

ENPH 491 Physics Of Nuclear Reactors Units: 3.50
The objective of this course is the understanding of the fundamental physics associated with a nuclear reactor. Topics include a brief review of basic nuclear physics, neutron interactions and cross-sections, neutron diffusion, neutron moderation, theory of reactors, changes in reactivity, control of reactors. Offered in alternate years.
Requirements: 3rd or 4th year standing in Engineering Physics
Offering Faculty: Faculty of Arts and Science

ENPH 493 Plasma Physics Units: 3.50
An introduction to plasma physics. The motions of single particles under the influence of various fields is considered first, followed by a fluid description of plasma. Topics also include plasma properties, waves in plasma, equilibrium and stability.
Requirements: ENPH 239 (PHYS 239), MTHE 227,
Offering Term: FW
Offering Faculty: Fac of Engineering Appl Sci

ENPH 495 Intro To Medical Physics Units: 3.00
Production and measurement of x-rays and charged particles for radiation therapy and nuclear medicine, interactions of radiation with matter and biological materials, interaction coefficients and radiation dosimetry, radiation safety, physics of medical imaging with examples from nuclear medicine ultrasound and magnetic resonance imaging.
Requirements: 3rd or 4th year standing in Engineering Physics
Offering Faculty: Faculty of Arts and Science

ENPH 555 Accelerated Engineering Physics Thesis Units: 4.00
Undergraduate thesis for students enrolled in the Accelerated Masters Program in Engineering Physics. They must develop an engineering solution to an assigned program under the supervision of a faculty member and give oral and written presentations to an examining committee. Grades will be based on the quality of the analysis of the problem, the proposed solution, and the written and oral presentations. The demonstration of effective written and oral communications skills is required. Students in the Accelerated Masters program are expected to work the summer before with the supervisor.
Requirements: ENPH 555 and acceptance in the Accelerated Masters Program Exclusions ENPH 455,456,457
Offering Term: FW
Offering Faculty: Fac of Engineering Appl Sci