

# Department of Physics

Chairperson:	Klushin, Leonid I.
Professors:	Bitar, Khalil M.; Chamseddine, Ali H.; El Eid, Mounib F.; Klushin, Leonid I.; Sabra, Wafic A.
Associate Professors:	Isber, Samih T.; *Tabbal, Malek D.; Touma, Jihad R.
Assistant Professor:	Polyakov, Dimitri A.
Visiting Assistant Professor:	Ibrahim, Tarek B.
Lecturers:	Research Associate: Christidis, Theodore C. <sup>P</sup> Bodakian, Berjouhi H.; <sup>P</sup> Mouawad, Nelly C.; <sup>P</sup> Roumieh, Mohammad A.
Instructors:	<sup>P</sup> Haddad, Jessy S.; <sup>P</sup> Itani, Hybat M.
Assistant Instructors:	<sup>P</sup> Ashkar, Rana A.; <sup>P</sup> Atallah, Nada K.; <sup>P</sup> Majdalani, Elissar S.; Mehio, Kawthar R.

## Undergraduate Program

The Department of Physics offers courses at the undergraduate level leading to a bachelor's degree in physics.

The program for the physics major includes the following courses: PHYS 101, PHYS 101L, PHYS 210, PHYS 210L, PHYS 212, PHYS 217, PHYS 220, PHYS 221L, PHYS 222, PHYS 226, PHYS 235, PHYS 236, and PHYS 257L. Moreover, two elective courses must be selected from PHYS 223, PHYS 228/228L, PHYS 231, PHYS 232, PHYS 248, PHYS 249. Also required are the following courses in mathematics: MATH 101, MATH 102, CMPS 200, MATH 201, MATH 202, and MATH 224.

Physics majors must obtain a cumulative average of at least 70 in the physics courses normally taken in the sophomore year (PHYS 210, PHYS 210L, PHYS 212) and a cumulative average of at least 70 in MATH 201 and 202 before they are allowed to proceed to junior level courses. Students who wish to transfer to physics must fulfill the above criteria.

No physics major is allowed to register in physics courses numbered 217 and above for a third time. Physics majors whose physics average falls below 70 or whose cumulative average in Math 201 and 202 is below 70 will be placed on departmental probation. If this probation is not removed within two semesters, the student will be dropped from the department.

The Department of Physics offers a minor in physics comprising one of the following sequences:

Sequence 1: PHYS 210, PHYS 210L, PHYS 211 (or PHYS 220), PHYS 212, PHYS 217, PHYS 221L, and PHYS 236

Sequence 2: PHYS 210, PHYS 210L, PHYS 211 (or PHYS 220), PHYS 212, PHYS 217, PHYS 228, and PHYS 228L

PHYS 101, PHYS 101L, PHYS 210, PHYS 210L, PHYS 211, PHYS 211L, and PHYS 212 are introductory courses for students of chemistry, computer science, or engineering.

PHYS 103, PHYS 204, PHYS 205, PHYS 204L, and PHYS 205L are introductory courses for students in nursing, public health, biology, petroleum studies, and for students wishing to enter the medical school but are not physics or chemistry majors.

PHYS 204, PHYS 205, PHYS 204L, and PHYS 205L are not equivalent totally or in part to the following: PHYS 210, PHYS 210L, PHYS 211, PHYS 211L or PHYS 212. Students shall receive credit for courses in only one of the preceding two sets.

**PHYS 101                      Introductory Physics I                      4.0; 4 cr.**  
Measurements, motion in one dimension, vectors, motion in two dimensions, Newton's laws with applications, work and energy, circular motion, linear momentum and collisions, rotation and angular momentum, oscillations, gravity, and elements of fluid mechanics. *Students shall receive credit for only one of PHYS 101 or PHYS 103. Pre- or corequisite: MATH 101. Annually.*

**PHYS 101L                      Introductory Physics Laboratory I                      0.2; 1 cr.**  
Error analysis, measuring devices, speed and acceleration, measurement of gravitational acceleration, forces, friction, circular motion, conservation of momentum, conservation of energy, ballistic pendulum, rotation, and simple harmonic motion. *Pre- or corequisite: PHYS 101. Annually.*

**PHYS 103                      Physics for the Life Sciences                      3.0; 3 cr.**  
Units and dimensions, scalars and vectors, kinematics in one and two dimensions, dynamics, work and energy, collisions, gravitation, and rotational motion. *Students shall receive credit for only one of PHYS 101 or PHYS 103. Each semester.*

**PHYS 200                      Understanding the Universe                      3.0; 3 cr.**  
An introductory course in astronomy restricted to undergraduate arts students. Basic astronomical tools, properties of the earth, solar system, sun, electromagnetic radiation, properties and evolution of stars, and the Milky Way galaxy. *Annually.*

**PHYS 204                      Classical Physics for Life Sciences                      3.0; 3 cr.**  
Fluids, heat and heat engines, gas dynamics, wave phenomena, and sound and light. *Prerequisite: PHYS 103 (or equivalent). Annually.*

**PHYS 204L                      Classical Physics for Life Sciences Laboratory                      0.2; 1 cr.**  
Techniques of laboratory work, surface tension, coefficient of viscosity, gas thermometer, Boyle's law, adiabatic compression of gases, mechanical equivalent of heat, waves on a stretched string, standing waves in air columns, geometrical optics I: reflection and refraction, geometrical optics II: mirrors and lenses, Michelson interferometer, and interference and diffraction. *Pre- or corequisite: PHYS 204. Annually.*

**PHYS 205                      Modern Physics for Life Sciences                      3.0; 3 cr.**  
Electricity: electric field and electric potential, electric current and circuits, and capacitance. Magnetism: magnetic field, magnetic materials, electromagnetic induction, electromagnetism applied to biological systems, introduction to special relativity, atoms and atomic structure, nuclei, and radioactivity. *Prerequisite: PHYS 103 (or equivalent). Annually.*

**PHYS 205L                      Modern Physics for Life Sciences Laboratory                      0.2; 1 cr.**  
Electric field mapping, capacitance and dielectric constants, basic oscilloscope operations, Wheatstone bridge, RC and RL circuits, measurements of magnetic induction fields, measurement of the charge to mass ratio of electrons, RC and RLC-circuits, Ohm's law, Planck's constant, atomic spectroscopy, and classical scattering. *Pre- or corequisite: PHYS 205. Annually.*

**PHYS 210                      Introductory Physics II                      3.0; 3 cr.**

Fluid statics, fluid dynamics, temperature, heat and first law of thermodynamics, kinetic theory of gases, heat engines, entropy and second law of thermodynamics, general properties of waves, sound waves and resonances, light and optics, interference, diffraction, and polarization. *Pre- or corequisite: MATH 201. Each semester.*

**PHYS 210L                      Introductory Physics Laboratory II                      0.2; 1 cr.**

Surface tension, gas thermometer, mechanical equivalent of heat, Boyle's law, adiabatic compression of gases, measurement of  $\gamma$  for air and fluid gas, standing waves on a stretched string, standing waves in air columns, geometrical optics: law of refraction and prism, mirrors and lenses, interference and diffraction, the spectrometer, and polarization. *Pre- or corequisite: PHYS 210. Each semester.*

**PHYS 211                      Electricity and Magnetism                      3.0; 3 cr.**

Electrostatics, current, resistance, Ohm's law, Kirchhoff's laws, RC circuits, magnetostatic theory, Ampere's law, Biot-Savart law, Faraday's law, LR circuit, RLC circuits, and a qualitative discussion of Maxwell's equations. *Pre- or corequisite: MATH 201. Each semester.*

**PHYS 211L                      Electricity and Magnetism Laboratory                      0.2; 1 cr.**

Electric fields, capacitance and dielectric constant measurements, construction and calibration of ammeter and a voltmeter, electrical circuits, Wheatstone bridge, potentiometer, Thomson's experiment, measurement of the force between two parallel current-carrying conductors, measurement of magnetic induction fields, basic oscilloscope operations, RL, RC, and RLC circuits. *Pre- or corequisite: PHYS 211. Each semester.*

**PHYS 212                      Modern Physics                      3.0; 3 cr.**

Special theory of relativity, introductory quantum mechanics, atomic physics, nuclear physics, and introduction to elementary particles. *Students cannot receive credit for both PHYS 212 and CHEM 218<sup>1</sup>. Pre- or corequisite: MATH 201. Each semester.*

**PHYS 217                      Mechanics                      3.0; 3 cr.**

Kinematics of particles motion, Newtonian formulation of mechanics, integration of Newtonian equations of motion, Lagrangian formulation of mechanics, Hamilton dynamics, central forces, linear oscillations, nonlinear oscillations and chaos, collisions, noninertial systems, coupled oscillations, and motion of rigid bodies. *Prerequisite: MATH 202. Annually.*

**PHYS 220                      Electromagnetic Theory                      3.0; 3 cr.**

Electrostatics: electric potential, Gauss' law, Poisson's and Laplace's equations, boundary conditions, electric currents, Faraday's law, Lenz's law, mutual inductance. Maxwell's equations, and propagation of electromagnetic waves. *Prerequisite: MATH 202. Annually.*

**PHYS 221L                      Junior Laboratory                      0.4; 2 cr.**

A course of experiments selected from the topics of diffraction,  $e/m$  ratio, magnetic field, RL, RC, RLC circuits, ohmic and non-ohmic devices, atomic spectroscopy, Milikan's experiment, Frank-Hertz experiment, speed of sound, gravitational acceleration, Planck's constant, and physical optics. *Annually.*

**PHYS 222                      Computational Physics                      0.3; 3 cr.**

Basics of numerical analysis: quadrature, solutions of algebraic and transcendental equations, methods for solving systems of linear equations, methods for solving differential equation, and scholastic methods. Applications: planetary motion, simple models of stars, nonlinear dynamics and chaos, potentials and fields, waves, random systems, computational fluid dynamics, statistical mechanics (phase transitions, Ising model), molecular dynamics, and quantum mechanics. *Prerequisites: MATH 201, MATH 202, and CMPS 200 (or equivalent). Annually.*

- PHYS 223**                      **Physical Optics**                      **3.0; 3 cr.**  
Wave theory of light, Maxwell's equations, superposition and polarization, interference, interferometers, diffraction, coherence, lasers, and holography. *Annually.*
- PHYS 226**                      **Solid State Physics**                      **3.0; 3 cr.**  
Electrons in one-dimensional periodic lattice, vibrations in one-dimensional periodic lattice, geometrical description of crystals, free-electron theory in metals, excitons, plasmons, polarons, lattice dynamics, semi-conductors, magnetic ordering, superconductivity, and electron gas in a magnetic field. *Prerequisites: PHYS 235 and PHYS 236. Annually.*
- PHYS 228**                      **Electronics**                      **3.0; 3 cr.**  
DC linear circuits, capacitors, inductors and transients, periodic waveforms, diodes, power supplies, operational amplifier, logic gates, timers, multiplexers, flip-flops, and counting circuits. *Students may not get credit for this course unless they take PHYS 228L. Annually. Fall semester.*
- PHYS 228L**                      **Electronics Laboratory**                      **0.3; 1 cr.**  
DC measurements, periodic waveforms, power supplies, transients, frequency and period measurements, operational amplifiers, and some digital circuits. *Pre- or corequisite: PHYS 228. Each semester.*
- PHYS 231**                      **Special Topics**                      **3.0; 3 cr.**  
*May be repeated for credit. Prerequisite: Consent of department.*
- PHYS 232**                      **Special Topics**                      **3.0; 3 cr.**  
*May be repeated for credit. Prerequisite: Consent of department.*
- PHYS 235**                      **Statistical Physics**                      **3.0; 3 cr.**  
Boltzmann distribution, Gibbs distribution, thermal radiation, heat and work, kinetic theory of gases, entropy and temperature, statistical mechanics of semiconductors, kinetics of chemical reactions, and phase transitions. *Prerequisite: PHYS 210. Annually.*
- PHYS 236**                      **Quantum Mechanics**                      **3.0; 3 cr.**  
Fundamental concepts: Bras, Kets, matrix representation of operators, change of basis; quantum dynamics: time evolution of quantum mechanical systems, spin; translational and rotational symmetry: Schrodinger equation in one and three dimensions; spherical symmetric systems: three-dimensional oscillator, hydrogen atom; theory of angular momentum: rotation operator, addition of angular momenta; time-independent perturbation theory, Zeeman effect, Stark effect, spin-orbit coupling, time-dependent perturbation theory, variational methods. *Prerequisites: MATH 224 (or equivalent) and PHYS 212. Annually.*
- PHYS 248**                      **Undergraduate Seminar**                      **1.0; 1 cr.**  
*Prerequisite: Senior standing. Annually.*
- PHYS 249**                      **Nuclear and Elementary Particle Physics**                      **3.0; 3 cr.**  
Introduction to scattering theory, nuclear phenomenology, nuclear models, nuclear radiation and fission and fusion, detectors and accelerators, properties of elementary particles, symmetries and transformations, and the standard model of elementary particles. *Prerequisites: Senior standing and consent of department. Annually.*

**PHYS 257L                      Advanced Laboratory                      0.6; 3 cr.**

A weekly lecture on instrumentation and a selection of six to eight experiments from the following list: transient and steady states of SH-oscillator, coupled oscillators bridge circuits, speed of sound in liquid, prism spectrometer, Frank–Hertz experiment, Planck constant, Currie temperature, magnetic susceptibility, measurement of gravitational acceleration, speed of light, Milikan’s drop oil experiment, the Hall effect, optics, the Faraday effect, and nuclear magnetic resonance. *Annually.*

**36+1<sup>1</sup> Credits in Physics<sup>2</sup>**

<b>Modes of Analysis</b>	<b>English and Arabic (9)</b>	<b>Humanities (12)</b>	<b>Social Sciences (3)</b>	<b>Sciences, Math, and Technology ( 36+ 11 + 13)</b>
Lecture Courses (9+12+3+36+1 <sup>1</sup> +13)	1. Required Arabic courses: ARAB 201A or B, or any upper level course (3) 2. Required English courses (6): ENGL 203(3), 204(3)	Required credits in the humanities: 12 credits including 6 credits from CVSP (see CVSP requirements under Civilization Sequence Program)	Recommended Economics (level 200) (3)	1. Required physics courses (24): PHYS 210(3), 212(3) 217(3), 220(3), 222(3), 226(3), 235(3), 236(3) 2. Two elective physics courses (6): PHYS 228 <sup>1</sup> (3), 223(3), 231(3), 232(3), 249(3), or other selected topics in physics 3. Required mathematics and technology courses (13): MATH 201(3), 202(3), 224(3), CMPS 200(4)
Seminar (1)				Elective PHYS 248(1)
Laboratory (6+1 <sup>1</sup> )				Required Physics Labs: PHYS 210L(1), 221L(2), 228L(1)1, 257L(3)
Research Project				The following courses may include a research project: PHYS 222, 226, 231, 232, 235, 236, 249

<sup>1</sup> Must be taken with PHYS 228L

<sup>2</sup> Plus 17 elective credits from outside the department

**THE REQUIREMENTS LISTED ABOVE APPLY TO STUDENTS WHO JOINED THEIR MAJOR AS OF OCTOBER 1, 2001–02. STUDENTS WHO JOINED A MAJOR PRIOR TO THAT DATE SHOULD CONSULT THE 2000–01 CATALOGUE.**

# Graduate Program

The department provides facilities for graduate work leading to the MS degree. The research activities of the department include material science, condensed matter physics, molecular physics, paramagnetic resonance, non-linear dynamics, astrophysics, high energy physics, superstring theory, and quantum gravity.

The MS program requires the completion of 21 credits of courses and a thesis. The courses consist of four core courses: PHYS 301, PHYS 302, PHYS 303, and PHYS 305, and nine credits of physics graduate electives. After completion of the four core courses, the student must pass a qualifying exam. The student must then select a thesis adviser who will present a thesis proposal to the physics faculty for approval. The MS degree is granted after the student defends his/her thesis successfully.

The PhD program in Theoretical Physics will be reactivated pending final approval by the New York State Education Department. For admission and graduation requirements, refer to the faculty and department webpages.

**PHYS 301                      Classical Mechanics                      3.0; 3 cr.**

D'Alembert's principle, variational principles and Euler Lagrange's equations, rigid bodies and small oscillations, Hamilton's mechanics, canonical transformations and Hamilton-Jacobi theory, stability, integrable systems, and chaotic motion. *Annually.*

**PHYS 302                      Statistical Mechanics                      3.0; 3 cr.**

Boltzmann distribution, density matrix, statistical ensembles, Fermi-Dirac and Bose-Einstein statistics and applications, phase transitions, mean-field theory, and applications. *Annually.*

**PHYS 303                      Electromagnetic Theory                      3.0; 3 cr.**

Boundary-value problems in electrostatics, multipoles, dielectrics, magnetostatics, time-varying fields and Maxwell's equations, and electromagnetic waves. *Annually.*

**PHYS 305                      Quantum Mechanics                      3.0; 3 cr.**

Hilbert space formulation of quantum mechanics, theory of angular momentum, Euler rotation, addition of angular momenta; symmetries and conservation laws: time reversal, parity, discrete symmetry; path integral formulation of quantum mechanics; approximation methods; identical particles; elementary scattering theory; introduction to relativistic quantum mechanics. *Annually.*

**PHYS 309/310                      Special Topics                      3.0; 3 cr. (each)**

*May be repeated for credit. Annually.*

**PHYS 330                      Principles of Environmental Physics                      3.0; 3 cr.**

Scope of environmental physics, review of gas laws, transport laws, radiation environment, microclimatology of radiation, momentum transfer, heat transfer, mass transfer, steady state heat balance, crop meteorology, energy for human use, and environmental spectroscopy. *Not open to physics graduate students. Prerequisites: PHYS 204 and 205 or equivalent and some knowledge of calculus. Annually.*

**PHYS 391/392                      Graduate Tutorial                      1-3 cr. (each)**

Physics 391 is usually given in the fall semester while PHYS 392 is given in the spring semester. For more than one student or if the same student is taking two tutorials at the same time the letters A, B, C... will be attached to distinguish these tutorials. *May be repeated for credit.*

**PHYS 399                      MS Thesis                      9 cr.**