Department of Physics

Chairperson: Isber, Samih T.
Professor Emeritus: Mavromatis, Harry A.
Professors: Bitar, Khalil M.; Chamseddine, Ali H.; El Eid, Mounib F.; Isber, Samih T.; Klushin, Leonid I.; Sabra, Wafic A.; Tabbal, Malek D.; Touma, Jihad R.
Associate Professors: Antar, Ghassan Y.; Christidis, Theodore C.
Assistant Professor: Kazan, Michel J.
Lecturers: ^1Bodakian, Berjouhi H.; ^2Ghamlouche, Hasan J.; ^3Roumieh, Mohammad A.; ^4Said, Aurore J.

BS in Physics

Mission Statement

The program leading to the Bachelor of Science emphasizes the fundamental concepts and principles of physics and their roles in a variety of disciplines, in a liberal arts setting. The educational focus of the Physics Department is to provide the students with high quality instruction in theoretical and experimental Physics. Consequently, theoretical courses, together with computer modeling experience and a comprehensive set of laboratory experiments, introduce the students to various methods of inquiry and research in physics. The emphasis is not only on subject instruction, but also on the development of communication and teamwork skills, as well as critical and analytical thinking. The program is designed to graduate well-rounded, free-thinking individuals with inquisitive minds who are well prepared for further study in basic and applied research and are capable of pursuing professional careers in a variety of diverse fields.

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

The requirements for a BS in Physics are 90 credits for students entering at the sophomore level. The distributions of these courses are as follows:

Degree Requirements

- 39 credits in Natural Sciences (27 credits required Physics courses; 6 credits elective Physics courses; 6 credits required Physics Lab courses).
- 40 credits if PHYS 228 is chosen as an elective.
- 12 credits in Quantitative Thought (9 credits in Math; 3 credits in CMPS 200 or EECE 230).
- 15 credits in free electives.
- General Education requirements that include 9 credits in Communication Skills (3 credits in Arabic; 6 credits in English - Eng. 203 and Eng. 204); 12 credits in the Humanities (including 6 credits in CVSP); 6 credits in Social Sciences. Also note that one natural science must be an approved General Education course from outside the major.

^1^ Part time
The program for the physics major includes the following required courses: PHYS 210, PHYS 210L, PHYS 212, PHYS 216, 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, and MATH 202.

Freshman students who intend to major in Physics are required to complete PHYS 101 and PHYS 101L with a minimum cumulative average of 70 and to complete MATH 101 and MATH 102 (or their equivalent) with a minimum cumulative average of 70. More details can be found under “Freshman sections” of this catalogue.

Students who wish to transfer to physics 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.

Physics majors whose physics average falls below 70 or whose cumulative average in MATH 201 and 202 is below 70 after three semesters in the major, will be dropped from the department.

The minor in physics requires 17 credits: PHYS 210, PHYS 211, PHYS 212, PHYS 221L or (PHYS 210L and PHYS 211L) and six more credits in physics selected from the following: PHYS 217, PHYS 220, PHYS 223, PHYS 222, PHYS 231, PHYS 235, PHYS 236.

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

PHYS 103, PHYS 103L, PHYS 204, PHYS 204L, PHYS 205 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 204L, PHYS 205 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.

**Course Descriptions**

**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. Pre- or corequisite: MATH 101. Students shall receive credit for only one of PHYS 101 or PHYS 103. 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 103L  Physics for the Life Sciences Laboratory  0.2; 1 cr.
Error analysis, measurements, position, speed and acceleration, ballistic pendulum static and dynamic forces, Atwood's machine, Linear Air Track I, collision, centripetal force and rotational inertia. Pre- or corequisite: PHYS 103. Annually.

PHYS 200  Understanding the Universe  3.0; 3 cr.
An introductory course in astronomy. Basic astronomical tools, properties of the earth, solar system, sun, electromagnetic radiation, properties and evolution of stars, and the Milky Way galaxy. Students cannot receive credit for PHYS 200 and PHYS 204 or PHYS 205 or PHYS 210 or PHYS 211 or PHYS 212. Each semester.

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  0.3; 1 cr.
Error analysis, Bernoulli’s Law, surface tension, coefficient of viscosity, thermal expansion, Boyle’s law, heat engine, 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, 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  0.3; 1 cr.
Error analysis, 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, transformers. Pre- or corequisite: PHYS 205. Annually.

PHYS 210  Introductory Physics II  3.1; 3 cr.
Review of classical mechanics, 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  0.3; 1 cr.
Error analysis, Atwood's Machine and motion down an incline, conservation of Mechanical energy, surface tension and viscosity, thermal expansion of solids, mechanical equivalent of heat, standing waves on a stretched string, standing waves in air columns, interference and diffraction, the spectrometer, Michelson interferometer. 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  0.3; 1 cr.
Error analysis, capacitance and dielectric constant measurements, electrical circuits and
Wheatstone bridge, measurement of the force between two parallel current-carrying conductors,
measurement of magnetic induction fields, basic oscilloscope operations, RL, RC, and RLC
circuits, measurement of the e/m ratio of electrons, transformers, Ohm's Law and resistivity.
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 and cosmology. Pre- or corequisite: MATH 201.
Students cannot receive credit for both PHYS 212 and CHEM 218. Each semester.

PHYS 216  Mathematical Methods for Physics  3.0; 3 cr.
Vector analysis, tenors, linear operators, Eigenvalue problems, determinants and matrices,
Sturm-Liouville problems, special functions, Fourier series and transforms, complex analysis.
Prerequisite: MATH 202. Annually.

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. Prerequisite: Junior standing. Annually.

PHYS 222  Computational Physics  3.0; 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 and MATH 202. 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 225  Introduction to Astronomy and Astrophysics  3.0; 3 cr.
Observation and instruments, photometry and magnitudes, radiation mechanisms, celestial
mechanics, stellar spectra and structure, stellar evolution, Milky Way, galaxies, cosmology.
Pre or corequisites: MATH 201, MATH 202, and PHYS 210. 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 pass PHYS 228L. Annually.**

**PHYS 228L**  **Electronics Laboratory**  3.0; 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: Schrödinger 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:** PHYS 212 and PHYS 216. **Annually.**

**PHYS 237**  **Introduction to Plasma Physics**  3.0; 3 cr.
Basic description of plasma: occurrence in nature and laboratory; basic plasma characteristics, applications: single particle motion in uniform, non-uniform and time-varying E and B fields. Relation of Plasma Physics to ordinary electromagnetics; fluid equation of motion. Plasma oscillations; ion, sound and electron waves; hydrodromagnetic and magnetosonic waves. Diffusion in weakly and fully ionized plasmas; decay of a plasma; collisions; single fluid Magneto-Hydro-Dynamics equations. Hydromagnetic equilibrium; classification of instabilities. Vlasov and Fokker-Planck equations; Landau damping; kinetic effects in a magnetic field. **Pre- and corequisites:** PHYS 217 and PHYS 220. **Annually.**

**PHYS 248**  **Undergraduate Seminar**  1.0; 1 cr.
**Prerequisite:** Senior standing. **Annually.**
PHYS 249  Elementary Particle Physics  3.0; 3 cr.
The standard model of elementary particles and their interactions represent the core content of the course. Topics to be discussed include, but are not limited to, relativistic kinematics, the Dirac equation, internal and space time symmetries, the quark model, gauge theories and the basic description of the electromagnetic, weak and strong interactions and their Feynman calculus, spontaneous breaking of symmetries and the Higgs mechanism. Prerequisites: PHYS 236 and/or senior standing. 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, prison 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. Prerequisite: PHYS 221L. Annually.

36 Credits in Physics

<table>
<thead>
<tr>
<th>Modes of Analysis</th>
<th>English and Arabic (9)</th>
<th>Humanities (12)</th>
<th>Social Sciences (6)</th>
<th>Natural Sciences (39)</th>
<th>Quantitative Thought (12)</th>
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<tr>
<td>Lecture Courses (9+12+6+30+12)</td>
<td>Required Arabic courses: ARAB 201A or any General Education Arabic communication skills (3)</td>
<td>Required credits in the humanities: 12 credits including 6 credits from CVSP (see CVSP requirements under Civilization Sequence Program)</td>
<td>Two courses: The Department recommends that at least one of them is a level-200 Economics course</td>
<td>Required physics courses (27): PHYS 210(3), 212(3), 216(3), 217(3), 220(3), 222(3), 226(3), 233(3), 236(3)</td>
<td>Required mathematics and technology courses (12 or 13): MATH 201(3), 202(3), CMPS 200(3), or EECE 230(3)</td>
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| Seminar (1) | PHYS 248(1) |
| Laboratory (6) | Required Physics Labs: PHYS 210L(1), 221L(2), 257L(3) |
| Research Project | The following courses may include a research project: PHYS 222, 226, 231, 232, 235, 236, 249 |

1 Students may not get credit for this course unless they pass PHYS 228L