Department of Physics

Chairperson: Antar, Ghassan Y.
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.; Kazan, Michel J.
Senior Lecturer Christidis, Theodore C
Lecturers: Al-Sayegh, Amara A.; Bodakian, Berjouhi H.; Malaeb-Hoseiky, Ola M.; Roumieh, Mohammad A.; Zaidouny, Lamis D.

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 with 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 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.

Degree Requirements
- 39 credits in Physics (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)
- 9 credits in Quantitative Thought (6 credits in Math, 3 credits in CMPS 200 or EECE 230)
- 12 credits in free electives

The General Education requirements 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
- 3 credits in one Natural Science course must be from outside the major and approved as a General Education course

The program for the physics major includes the following required courses: PHYS 210 or PHYS 211, PHYS 210L or PHYS 211L, 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 225, PHYS 228/228L, PHYS 231, PHYS 232, PHYS 248, PHYS 249, or any other elective offered in PHYS. Also required are the following courses in mathematics: MATH 201, MATH 202, and CMPS 200 or EECE 230.

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 the Freshman Courses section 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 or 211, PHYS 210L or 211L and 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, 8 credits which include PHYS 210 or PHYS 211, PHYS 212, PHYS 221L and 9 more credits selected from PHYS 217, PHYS 220, PHYS 226, PHYS 235, PHYS 236 or a special topic course.

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 geosciences, 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. Every 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 may not receive credit for PHYS 200 and any of the following: PHYS 204, PHYS 205, PHYS 210, PHYS 211, PHYS 212. Every semester.

PHYS 204  Classical Physics for Life Sciences  3.0; 3 cr.
Solids and fluids, thermal physics and processes, heat and heat engines, the laws of thermodynamics, gas dynamics, vibrations and wave phenomena, sound, reflection and refraction of light, mirrors and lenses, wave optics and optical instruments. 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.
Part I: Electric field, electric potential, Gauss's law, capacitance, electric current and circuits and Ohm's law. Magnetic field, Ampere's law, electromagnetic induction, electromagnetism applied to biological systems. Part II: Introduction to relativity, atoms and atomic structure, nuclei, elementary particles 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. Every 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. Every semester.

PHYS 211  Electricity and Magnetism  3.0; 3 cr.
Electrostatics, current, resistance, Ohm's law, Kirchhoff's laws, RC circuits, magnetic field, 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. Every 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. Every 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. Every semester.

PHYS 216  Mathematical Methods for Physics  3.0; 3 cr.

PHYS 217  Mechanics  3.0; 3 cr.
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 set of experiments selected from the topics of: diffraction, e/m ratio, magnetic field, RL, RC,
RLC circuits, ohmic and non-ohmic devices, atomic spectroscopy, Millikan’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: Numerical solutions of algebraic and transcendental equations,
methods for solving systems of linear and differential equations 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. Junior Standing. 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  Electrons  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 cannot 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.
Every 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 Physic  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: Senior standing. 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 symmetrical
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,
single particle motion in uniform, non-uniform and time-varying E and B fields. The fluid
description and magnetohydrodynamic equations. Electrostatic, hydrodromagnetic and
magnetosonic waves. Diffusion in weakly and fully ionized plasmas. Hydromagnetic equilibrium;
classification of instabilities. Kinetic effects using the Vlasov and Fokker-Planck equations and

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, prism spectrometer, Frank–Hertz experiment, Planck constant, Currie
temperature, magnetic susceptibility, measurement of gravitational acceleration, speed of
light, Millikan’s drop oil experiment, Hall effect, optics, Faraday effect, and nuclear magnetic
resonance. Prerequisite: PHYS 221L. Annually.
## 39 Credits in Physics

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<tr>
<th>Modes of Analysis</th>
<th>English and Arabic (9)</th>
<th>Humanities (12)</th>
<th>Social Sciences (6)</th>
<th>Physics and Natural Sciences (39+3+12)</th>
<th>Quantitative Thought (12)</th>
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<tr>
<td>Lecture Courses (9+12+6+33+3+12+9)</td>
<td>• One required Arabic course: ARAB 201A or any General Education Arabic communication skills (3)</td>
<td>• Four required courses in humanities (12), including 6 credits from CVSP</td>
<td>• Two required courses¹</td>
<td>• Nine required courses: PHYS 210 or 211, 212, 216, 217, 220, 222, 226, 235, 236 (27)</td>
<td>• Three required: MATH 201, 202, and CMPS 200, or EECE 230 (9)</td>
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<td>• Two Required English courses: ENGL 203 and 204 (6)</td>
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<td>Seminar (1)</td>
<td>• PHYS 248(1)</td>
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<td>Laboratory (6)</td>
<td>• Required Physics Labs: PHYS 210L(1) or 211L (1), 221L(2), 257L(3) (6)</td>
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<td>Research Project</td>
<td>• The following courses may include a research project: PHYS 222, 226, 231, 232, 235, 236, 249</td>
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¹ Approved as General Education Courses(s)

² Students may not get credit for this course unless they pass PHYS 228L.