Department of Physics

Chairperson:	Touma, Jihad R.
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Professors:	Antar, Ghassan Y., 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:	Christidis, Theodore C.; Kazan, Michel J.
Lecturers:	[P]Al-Sayegh, Amara A.; [P]Bodakian, Berjouhi H.; [P]El-Daif, Ounsi R.; [P]Roumieh, Mohammad A.

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

The degree requirements is divided into the General Education requirements, set by the university in accordance with its mission statement as a Liberal Art institution, and the Physics requirements set by the Physics Department.

The General Education requirements include:

- 9 credits in Communication Skills divided into 3 credits in Arabic and 6 credits in English
- 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 Physics requirements include:

- 39 credits in Physics divided into 27 credits of required Physics courses, 6 credits elective Physics courses, and 6 credits of required Physics Lab courses (the total number is 40 credits if PHYS 228/228L are chosen as an elective)
- 9 credits in Quantitative Thought including 6 credits in Math (MATH 201 and 202) and 3 credits in CMPS 200 or EECE 230
- 12 credits of free electives

The program for the Physics major includes the following required courses: PHYS 212, PHYS 214, PHYS 216, PHYS 217, PHYS 220, 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 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 2.2 (or 70) and to complete MATH 101 and MATH 102 (or their equivalent) with a minimum cumulative average of 2.2 (or 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 2.2 (or 70) in the physics courses normally taken in the sophomore year and a cumulative average of at least 2.2 (or 70) in MATH 201 and 202 before they are allowed to proceed to junior level courses.

Physics majors whose physics average falls below 2.2 (or 70) or whose cumulative average in MATH 201 and 202 is below 2.2 (or 70) after three terms in the major will be dropped from the Department.

The minor in physics requires 17 credits divided into 8 credits from the following courses PHYS 210 or PHYS 211, PHYS 212, PHYS 221L and 9 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 term.*

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 term.*

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.
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 term.*

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 term.*

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 term.*

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 term.*

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 term.*

PHYS 214 Introduction to Vibrations and Waves 3.0, 3 cr.
This course aims to introduce students to the physical and mathematical properties shared by wave phenomena across scales and states of matter. It begins with the vibrations of a single particle, whether free or forced, with due consideration for resonances. It then moves on to collective vibrations of coupled systems of particles, with particular emphasis on normal modes of vibrations. Proper wave-like behavior will then appear in the continuous limit of the particle description and its properties (including reflection, transmission, refraction, polarisation, interference, and diffraction to list a few). In support of the analytic (as opposed to descriptive) approach to the subject, advanced mathematical techniques (to do with ordinary differential equations, linear algebra, and Fourier analysis) will be introduced as and when needed.

PHYS 216 Mathematical Methods for Physics 3.0; 3 cr.
Vector analysis, tensors, 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 Physics Laboratory 6.0, 3 cr.
This course is intended to help students acquire basic practical skills that are used in experimental physics. The course introduces students to some of the basic equipment that are used in this discipline. Experiments will cover a range of phenomena, including, electricity and magnetism, mechanics, optics, waves and modern physics. *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: CMPS 200 or EECE 230, 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.
Wave theory of light, Maxwell's equations, superposition and polarization, interference, interferometers, diffraction, coherence, lasers, and holography. *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 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 cannot receive credit for this course unless they pass PHYS 228L. Annually.*

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. Every term.*

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: Senior standing. Annually. annualyy.*

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, 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 Landau damping. *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.
Students perform a selection of six to eight experiments from the following list: transient and steady states of SH-oscillator, coupled oscillators, Frank–Hertz experiment, Planck constant, Currie temperature, magnetic susceptibility, Millikan's drop oil experiment, Hall effect, Faraday rotation, Johnson noise, atomic spectroscopy, Zeeman effect, Paramagnetic resonance, pulsed nuclear magnetic resonance, X-ray diffraction, Brownian motion and optical pumping. *Prerequisite: PHYS 221L. Annually.*

39 Credits in Physics

Modes of Analysis	English and Arabic (9)	Humanities (12)	Social Sciences (6)	Physics and Natural Sciences (39+3+12)	Quantitative Thought (9)
Lecture Courses (9+12+6+33+3 +12+9)	• Required Arabic course (3) • Two required English courses: ENGL 203 and 204 (6)	• Four required courses in humanities (12), including 6 credits from CVSP	• Two required courses[1]	• Nine required courses : PHYS 212, 214, 216, 217, 220, 222, 226, 235, 236 (27) • Two elective physics from PHYS 223, 225 (228 + 228L)[2],231, 232, 237, 249, or other selected topics (6) • One natural science course from outside the major (3) • Four free elective courses (12) from inside or outside the department	• Three required : MATH 201, 202, and CMPS 200, or EECE 230 (9)
Laboratory (6)				• Required Physics Labs: PHYS 221L(3), 257L(3) (6)	
Research Project				• The following courses may include a research project: PHYS 222, 226, 231, 232, 235, 236, 249	

1) Approved as General Education Courses(s)
2) Students may not get credit for this course unless they pass PHYS 228L.