

# Physics (PY)

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All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.

## **PY 1101. General Physics I LAB. 1 Semester Hour.**

## **PY 1300. Physics Concepts & Application. 3 Semester Hours.**

Designed to convey the considerable bearing physical laws have on common experience. Applications in trades, professions and industry are provided. Directed to ward non-science majors to help them evaluate the evidence of their own experience and see the pervasiveness of physics in virtually every aspect of technological society. Topics: Motion, Gravity, Relativity, Energy and Power, Energy Resources, Waves, Sound and Electricity.

## **PY 1301. General Physics I. 3 Semester Hours.**

## **PY 1310. Modern Astronomy. 3 Semester Hours.**

A course that will be of interest to students not majoring in science, engineering or mathematics as well as those majoring in these fields. This course deals mainly with stellar and galactic astronomy but begins with a brief survey of our solar system including orbits and Kepler's laws. The emphasis is placed upon how compositions, ages and evolution are deduced. The course will be somewhat quantitative but the mathematical requirements are minimal.

## **PY 1401. General Physics I. 4 Semester Hours.**

This course is an algebra-based introduction intended for non-physics and non-engineering students. Topics covered include kinematics, Newtonian dynamics, work, energy, momentum, rotational kinematics and dynamics, simple harmonic oscillations, fluids and thermodynamics. (Fall; Spring; Summer) (Lecture 3 hours; Lab 4 hours.) (PHYS 1401) Additional fee associated with this course. See fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>.

## **PY 1402. General Physics II. 4 Semester Hours.**

This course is an algebra-based introduction intended for non-physics and non-engineering students. Topics covered include electricity, magnetism, waves and optics, atomic and nuclear physics (Fall; Spring; Summer) (Lecture 3 hours; Lab 4 hours.) (PHYS 1402) Additional fee associated with this course. See fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>. Prerequisite: PY1401.

## **PY 1404. University Physics I. 4 Semester Hours.**

Calculus-based physics course intended for physics, chemistry, and engineering students. This course covers the basics of Newtonian Mechanics including kinematics and dynamics of linear and rotating systems. The energy and momentum approach is also covered in this course as are applications of these concepts to rotational dynamics, simple harmonic oscillations, acoustics, and fluid mechanics. (Fall; Spring; Summer) (Lecture 3 hours; Lab 4 hours.) If you took MT2412 or are concurrently taking MT2412, you will be able to register for this course. (All courses serving as prerequisites in the School of Science, Engineering, and Technology must be completed with a "C" or better in order to advance to the next sequenced course.) An additional fee is associated with this course. See the fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>.

## **PY 2404. University Physics II. 4 Semester Hours.**

Calculus-based physics course intended for physics, chemistry, and engineering students. This course covers the concepts of thermodynamics, waves and optics, electricity, DC and AC circuits, and magnetism. (Spring; Summer) (Lecture 3 hours; Lab 4 hours.) Prerequisite PY1404, MT 2412 (All courses serving as prerequisites in the School of Science, Engineering, and Technology must be completed with a "C" or better in order to advance to the next sequenced course.) You must have taken MT2413 or are concurrently taking MT2413 to register for this class. An additional fee is associated with this course. See the fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>.

## **PY 3101. Modern Physics Lab. 1 Semester Hour.**

This course focuses on the exploration of modern scientific methods through the measurement of several classical and modern physical constants. Experiments include:  $e/m$ , Millikan Oil Drop, Photo-electric Effect, Speed of Light, Franck-Hertz, plus additional experiments available in the department. (Fall only) (Lab 4 hours per week; usually con current with PY 3301.) Additional fee associated with this course. See fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>. Prerequisite: PY2404.

## **PY 3102. Nuclear Physics Lab. 1 Semester Hour.**

This course focuses on the experiments relevant to the behavior of atomic nuclei including studies of nuclear decay, nucleon scattering, radiation scattering. (Lab 4 hours per week; usually concurrent with PY 3302.) Additional fee associated with this course. See fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>.

## **PY 3110. Computational Physics Lab. 1 Semester Hour.**

This course may be students' first exposure to computer programming, so the first three weeks are devoted to developing a competency in the programming language Python. After this, students will write code in Python using computational techniques, such as least-squares fitting, finite difference (numerical differentiation), quadrature (numerical integration), and the Runge-Kutta method (ordinary differential equation solver), to solve problems ranging from quantum mechanical theory to biological models (predator-prey interaction). An independent project will be assigned utilizing additional computational methods (matrix methods, partial differential equation solvers, and Monte Carlo methods). (Fall or Spring).

**PY 3113. Electronics Lab I. 1 Semester Hour.**

DC circuits; the diode as a nonlinear device; the oscilloscope; RC circuits; RC filters; LC resonant circuit; rectifier; signal diodes; diode clamp; emitter follower; current source; common emitter amplifier; transistor as a switch; op-amp open-loop gain; inverting and non-inverting op-amps; op-amp follower and current source; summing amplifier; op-amp as an integrator, a differentiator, an active rectifier, and an active clamp; FET transistor; FET current source and source follower; FET as a voltage-controlled resistance; amplitude modulation and AM radio; input and output characteristics of integrated gates: TTL and CMOS. Prerequisite: EG 2152; corequisite: EG 3356. (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.) Additional fee associated with this course. See fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>.

**PY 3114. Electronics Laboratory II. 1 Semester Hour.**

Flip-flops; counters; shift registers; the cascading 16-bit counter with added display and keypad; programmable divide-by-n counters; period meters; capacitance meters; memory; RAM; divide-by-3; memory-based state machines; the dynamic diode curve tracer; the grounded emitter amplifier; current sources; the Ebers-Moll model; push-pull amplifiers; differential amplifiers; the bootstrap circuit; the Miller effect; the Darlington pair; the super beta; the analog switch and its applications: chopper circuits; sample-and-hold circuits; switched capacitor filters; voltage inverter circuits; A/D and D/A converters; the phase-locked loop circuit; the frequency multiplier. Prerequisite: EG 3156; Co-requisite: EG 3357. (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.) Additional fee associated with this course. See fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>.

**PY 3120. Robotics Lab. 1 Semester Hour.**

This is a beginning course in robotics. We will be utilizing Vex Robotics kits, Robolab software and various Lego Robotics materials. The objective of this course is to introduce the student to basic programming as well as problem solving strategies. This course will involve students in the development, building and programming of a robot, capable of performing a number of simple tasks. Students will work hands-on in teams to design, build, program and document their progress. Topics include motor control, gear ratios, torque, friction, sensors, timing, program loops, logic gates, decision-making, timing sequences, propulsion systems and binary number systems. (Fall or Spring).

**PY 3125. Special Topics Laboratory. 1 Semester Hour.**

Additional fee associated with this course. See fee schedule for details at <https://www.stmarytx.edu/admission/financial-aid/tuition/>.

**PY 3301. Modern Physics. 3 Semester Hours.**

This is an introductory course on modern physics developed during the early twentieth century. There is a very large historical component outlining the key scientists (Einstein, Planck, Thomson, Compton, Rutherford, Bohr, Schrodinger, Heisenberg, and others) and their experiments that demonstrated the need for the classical theory of physics to be revised, as well as a quantitative component with many opportunities in applying these new revised theories for solving problems. Material mainly covered is the special theory of relativity and quantum mechanics. In addition to being an introductory course, students will also be better prepared after completion to handle the theoretical concepts and mathematics of a more advanced relativity or quantum mechanics course. (Fall) (Lecture 3 hours) Prerequisite PY2404, MT 2413 (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.).

**PY 3302. Nuclear Physics. 3 Semester Hours.**

A course that focuses on the scientific study of the properties and behavior of atomic nuclei instruction in nuclear reaction theory, quantum mechanics, energy conservation, nuclear fission and fusion, strong and weak atomic forces, nuclear modeling, nuclear decay, nucleon scattering, pairing, photon and electron reactions, statistical methods, and research equipment operation and maintenance. (Lab 4 hours per week) Prerequisite: PY 3301. (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.).

**PY 3303. Mathematical Methods in Physics. 3 Semester Hours.**

This course introduces students to some of the more advanced mathematical methods and ideas most widely used to describe physical processes covered in upper-level courses. Major topics to be covered include vector calculus, orthogonal curvilinear coordinates, topics in linear algebra, topics in ordinary and partial differential equations, complex analysis, and asymptotics. Prerequisite: PY2404, MT2413. (Fall).

**PY 3304. Thermodynamics. 3 Semester Hours.**

This course focuses on the basic concepts of thermodynamics from the microscopic point of view. Methods of statistical physics are used to define entropy and temperature, heat and work, ideal gas behavior. Applications to chemical reactions, Fermi and Bose systems in condensed matter physics and phase transformations are discussed. Prerequisite: PY3303 (Fall or Spring) (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.).

**PY 3305. Physical Optics. 3 Semester Hours.**

Physical principles are used to develop a firm fundamental understanding of optics and imaging. Main topics include light as an electromagnetic wave, light at an interface, polarization, interference, and diffraction. Also includes a brief introduction to modern optics and a discussion of the fundamental limitations of an optical system and its effect on images. (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.).

**PY 3307. Mechanics. 3 Semester Hours.**

This course presents kinematics and dynamics of particles using Newtonian, Lagrangian and Hamiltonian techniques. Topics include central force motion, oscillations and normal mode analysis, non-linear dynamics, rotating rigid bodies and motion in non-inertial reference frames. Prerequisite: PY3301. (Spring) (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.).

**PY 3308. Quantum Mechanics. 3 Semester Hours.**

The purpose of this course is to provide a comprehensive introduction to the principles of quantum mechanics and includes following topics: formal development of the postulates of quantum theory, representation of states, quantum mechanics in one and three dimensions, angular momentum, spin and perturbation theory. Prerequisite: PY3301. (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.)

**PY 3313. Electronics. 3 Semester Hours.**

Theory of semiconductors; discrete devices and integrated circuits; linear and digital operation. (EG 2341, EG 2152, EG 2352, EG 2353 are prerequisites.) Note: PY 1404 and PY 2404 are prerequisites and MT 3311 is a co-requisite for 3000 level physics courses. (same as EG3356) (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.)

**PY 3314. Electronics. 3 Semester Hours.**

Theory of semiconductors; discrete devices and integrated circuits; linear and digital operation. (EG 2341, EG 2152, EG 2352, EG 2353 are prerequisites.) Note: PY 1404 and PY 2404 are prerequisites and MT 3311 is a co-requisite for 3000 level physics courses. (same as EG3357) (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.)

**PY 3325. Special Topics. 3 Semester Hours.**

This course is used to introduce special topics of interest. Topics in the past have included the following: Particle Physics, Biophysics, Functional Neuroimaging, Fiesta of Physics Outreach, Astrophysics, and Cosmology. Note: PY 1404 and PY 2404 are prerequisites and MT 3311 is a co-requisite for 3000-level physics courses. (All courses serving as prerequisites in the School of Science, Engineering, and Technology must be completed with a "C" or better in order to advance to the next sequenced course.)

**PY 3350. Biophysics. 3 Semester Hours.**

Biophysics is an interdisciplinary science that employs and develops theories and methods of the physical sciences for the investigation of biological systems. Currently, biophysics is one of the fastest growing physics research areas that is vital to many other fields, including medicine, bioengineering, and biology. There are two major ways that the biological processes are affected by physics: (i) through physical principles underlying molecular interactions and (ii) through development and application of physical methods to studies of biological systems: DNA, proteins, lipid membranes, and cells. (Spring even years). Prerequisite: PY3301 and BL1402).

**PY 4308. Advanced Quantum Mechanics. 3 Semester Hours.**

This course is the second semester continuation of Quantum Mechanics. We will revisit angular momentum then proceed to perturbation theory and scattering. The remainder of the semester will be devoted to understanding the application of quantum mechanics to a variety of disciplines and phenomena including relativistic quantum mechanics, and brief introductions to quantum electrodynamics and quantum chromodynamics. Prerequisite: PY3308. (Fall odd years).

**PY 4309. Electromagnetic Theory. 3 Semester Hours.**

This course is an intermediate level discussion of Maxwell's Equations and their applications: electrostatics and dynamics, magnetic fields and magnetic effects, and electro-magnetic waves, both in vacuum and in materials. (All courses serving as prerequisites in the School of Science, Engineering and Technology must be completed with a "C" or better in order to advance to the next sequenced course.) (Fall even years).

**PY 4310. Advanced Electromagnetic Theory. 3 Semester Hours.**

The goal of this course is to expose students to advances topics in classical electromagnetism with a contemporary point of view. Broadly, four areas will be considered: Electromagnetic sources, propagation of electromagnetic radiation, the interaction of electromagnetic radiation with materials, and physical optics. Specific topics include antennas, Lienard-Wiechert potentials, synchrotrons, lasers, Gaussian beam propagation, electrodynamics of materials (electrons, phonons, plasmons, artificial materials, magneto-electrics), and nonlinear optics. Connections with current research will be made for each of these topics. An approximate lecture schedule is included below. The emphasis on this course is not mathematical physics, but rather stepping back and developing some physical insight into modern topics in E&M. Prerequisite: PY 4309. (Spring even years).