PHYSICS

About Us

Located on the beautiful, Lakeshore campus of Loyola Univeristy Chicago in Cudahy Science Hall, the Department of Physics prepares students for future STEM careers. Students in the Department of Physics will learn the principles of physics, contribute to new physical knowledge and seek to foster scientific integrity. These goals are consistent with the mission of Loyola University Chicago: searching for truth and living for others. The Department strives to create a welcoming environment for its students that encourages student success and supports their well being as they work toward their career goals at Loyola. The Department and the Physics Club hold several social events each year to build community among the Loyola physics students and faculty.

We offer several undergraduate degree plans (p. 1) with BS degree programs in Physics, Biophysics, Theoretical Physics/Applied Mathematics and Physics/Computer Science. We also offer a special dual degree in physics and engineering, wherein students receive a BS in Physics from Loyola and a bachelor of engineering degree from an affiliated school. In collaboration with the School of Education, the department also offers a BS/MEd degree that prepares students to teach in high schools. In addition, the department serves a large number of students seeking to satisfy ancillary requirements for other majors, core curriculum requirements, as well as pre-health-professional requirements for medical, dental, and pharmacy schools.

The Department has several areas of active physics research, including astroparticle physics, computational physics, cosmology, biophysics, fluid dynamics, optics, and quantum mechanics. Students have the opportunity to explore these different areas of physics research with faculty (https://www.luc.edu/physics/research/) and are encouraged to participate in projects. Students often present their research at local and national conferences, and they can receive fellowships (https://www.luc.edu/physics/undergraduateexperiences/researchfellowships/) from LUC to support their research.

You can read more about the undergraduate experience offered by the Physics Department here. Please explore the website or contact the department chair for more information about our department.

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Physics in the Science Core

The Physics Department offers several courses for non-science majors seeking to satisfy natural science core curriculum requirements: PHYS 101 Liberal Arts Physics, PHYS 102 Planetary and Stellar Astronomy, and PHYS 106 Physics of Music. These courses emphasize an appreciation of the basic laws, overall structure, and beauty of the physical universe. In addition, as part of the natural science core, these courses discuss the scientific method, and stress the importance of methodological competence as well as ethics in forming critical judgments on technically oriented societal issues. More information on Loyola's Core Curriculum can be found here (https://www.luc.edu/physics/undergraduateexperiences/).

Undergraduate Programs

- Biophysics (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/physics/biophysics-bs/)
- Physics (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/physics/physics-bs/)
- Physics (BS) + Engineering (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/physics/physics-bs-engineering-bs/)
- Physics Minor (https://catalog.luc.edu/undergraduate/arts-sciences/physics/physics-minor/)
- Physics with Computer Science (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/physics/physics-computer-science-bs/)
- Theoretical Physics and Applied Mathematics (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/physics/theoretical-physics-applied-mathematics-bs/)

Physics Department Academic Policies

Mathematics Readiness

Entering students with American College Test (ACT) mathematics scores of 25 or higher, or Scholastic Aptitude Test (SAT) mathematics scores of 570 or higher, automatically qualify to start the sequence of physics courses for the major in physics. Students who do not so qualify should consult the physics chairperson to determine the appropriate sequence of courses.

Policy on Multiple Majors and Minors

The following modifies and clarifies the "Double-Dipping (https://www.luc.edu/media/lucedu/cas/pdfs/Double%20Dipping%20Policy.pdf)" policy of the College of Arts & Sciences, as it pertains to the Department of Physics.

The following degree programs are housed in or jointly housed in the Physics Department:

1. Bachelor of Science in Physics (PHYS-BS)
2. Bachelor of Science in Biophysics (BPHY-BS)
3. Bachelor of Science in Physics with Computer Science (PCSC-BS)
4. Bachelor of Science in Theoretical Physics/Applied Mathematics (TPAM-BS)
5. Physics Minor (PHYS-MINR)

They will be referred to as “majors or minor in the Physics Department” in this document.

- A combination of PHYS-BS and PCSC-BS **is not allowed**.
- Any other combination of two majors in the Physics Department (aside from PCSC-BS) **is allowed.**
- Any combination of three majors in the Physics Department **is not allowed**.
- PHYS-MINR **is not allowed** together with any major housed in Physics Department.
- A Mathematics Minor (MATH-MINR) **is not allowed** together with TPAM-BS, but **is allowed** with any other major in the Physics Department. For qualifying students, the MATH-MINR may be earned by taking **one** additional, upper-level mathematics course (MATH 3XX).
- A Computer Science Minor (COMP-MINR) **is not allowed** together with PCSC-BS.

- An Information Technology Minor (ITEC-MINR) **is not allowed** together with PCSC-BS.
- The combination of a B.S. in Mathematics (MATH-BS) and any single major housed in the Physics department **is allowed**.
- A triple major of MATH-BS, TPAM-BS, and any other major housed in the Physics Department **is not allowed**.
- A triple-major combination of PCSC-BS, PHYS-BS, and any of the following: B.S. in "Communication Networks and Security" (CNWS-BS), "Computer Science" (COMP-BS), "Information Technology" (ITEC-BS), or "Software Engineering" (SWEN-BS) is **not allowed**.
- A triple-major combination of PHYS-BS, BPHY-BS, and any of the following: B.S. in Biology (BIOL-BS), Biology with Molecular Biology Emphasis (BIOM-BS), or Biology with Ecology Emphasis (BIOE-BS) **is not allowed**.

Grade Requirements

A grade of "C-" or better must be earned in all physics courses required for the major or minor in physics.

Continuation in the Major

A student will be withdrawn from any major offered by the Physics Department if either of the following conditions exist:

1. The student receives two grades less than C- (excluding grades of W but including grades of WF) in a two year period in courses required for the major (including courses offered by the Math and Computer Science departments).
2. The student has a cumulative GPA in majors' courses (including the ancillary courses) less than 2.00 after completion of the first two year sequence (i.e., upon completion of MATH 264 Ordinary Differential Equations and PHYS 301 Mathematical Methods in Physics and PHYS 314 Theoretical Mechanics I).

The chair of the Physics Department may reinstate the student in exceptional cases.

Prerequisite Courses

PHYS 121 College Physics I with Calculus Lecture/Discussion and PHYS 122 College Physics II with Calculus Lecture/Discussion are basic prerequisites for all physics courses. PHYS 111 College Physics I Lec / Dis, PHYS 112 College Physics II Lec/Disc will be accepted in lieu of these courses with the permission of the department chairperson. Mathematics courses listed as prerequisites to a physics course may, with the permission of the chairperson, be taken concurrently with the physics course or may be excluded in special instances. MATH 264 Ordinary Differential Equations is a prerequisite to all 300 level physics courses. Part II of a given course may not be taken before Part I.

Advanced Placement in Physics

Entering non-majors who have received scores of 4 or higher on the Physics B or Physics C Advanced Placement examinations of the College Entrance Examination Board are eligible to receive college credit for the corresponding lecture courses. A score of 4 or higher in the Physics C examination, plus departmental approval, are necessary for receipt of credit by majors. No credit is available for laboratory courses.

Requirements for Departmental Honors

In addition to the general requirements for the major, a student seeking departmental honors must satisfy the following two criteria:

- Minimum overall GPA of 3.7
- Department-approved research project that culminates in a journal article, seminar presentation, or conference proceeding.

Qualifying students must email the Department Chair (Constantin Rasinariu) for departmental approval. Students should then submit the approval to their CAS advisor.

Undergraduate Policies and Procedures

Please see Undergraduate Policies and Procedures (https://catalog.luc.edu/academic-standards-regulations/undergraduate/) for academic policies that supersede those of academic units within the University.

Physics (PHYS)

PHYS 101 Liberal Arts Physics (3 Credit Hours)
Pre-requisites: ENVS 101 or equivalent; please check requirements for declared majors/minors for exceptions
For non-science majors. Selected topics from classical and modern physics emphasizing beauty, symmetry, and simplicity. Contemporary issues of physics and society.
Knowledge Area: Tier 2 Scientific Knowledge
Outcomes:
Understanding of interaction between theory and experiment, role of physics in society, science vs. nonscience; solve problems using algebra, geometry, vectors, and graphs; synthesize disparate physics topics

PHYS 102 Planetary and Stellar Astronomy (3 Credit Hours)
Pre-requisites: ENVS 101 or equivalent; please check requirements for declared majors/minors for exceptions
This course covers the astronomy of the solar system and planetary science as well as the astronomy of stars and galaxies. This includes study of earth and comparative study of all the planets, as well as the birth, evolution, and death of stars, the clustering of stars and galaxies, the expanding universe and cosmology.
Knowledge Area: Tier 2 Scientific Knowledge
Outcomes:
Students will demonstrate an understanding of the fundamental knowledge and concepts in astronomy, the qualitative and quantitative reasoning used, and how this science can be applied

PHYS 106 Physics of Music (3 Credit Hours)
Pre-requisites: ENVS 101 or equivalent; please check requirements for declared majors/minors for exceptions
Language, structure, history and styles of music; motion, force, energy and waves applied to production of sound; physical properties of instruments and musical acoustics.
Knowledge Area: Tier 2 Scientific Knowledge
Outcomes:
Knowledge of music fundamentals; understand how instruments function; apply physics concepts and experimentation to analyze the production of music and acoustics

PHYS 111 College Physics I Lec / Dis (3 Credit Hours)
Pre-requisites: Math Placement Test or MATH 118
Non-calculus introduction to vectors, kinematics, Newtonian mechanics of translational, rotational, and oscillatory motion, energy and momentum conservation, and thermodynamics.
Interdisciplinary Option: Forensic Science
Outcomes:
Understanding of analytical description of motion and application of conservation laws; develop scientific insight and proficiency in solving representative problems

PHYS 111L College Physics Laboratory I (1 Credit Hour)
Pre- or co-requisites: PHYS 111 or PHYS 121; Prerequisite: MATH 118 or MDT
Laboratories cover selected topics in introductory mechanics, including freefall, uniform circular motion, work-energy, collisions, rotational motion, and harmonic motion.
Interdisciplinary Option: Forensic Science
Outcomes:
Experience and familiarity with basic measuring devices and simple mechanics equipment; Understand measurement errors and their propagation, plotting and interpretation of data, the connection between theory and experiment for selected topics in elementary mechanics

PHYS 112 College Physics II Lec/Disc (3 Credit Hours)
Pre-requisites: PHYS 111 or equivalent
PHYS 111 and 112 provide a non-calculus introduction to physics. Topics include electricity and magnetism, sound, optics, and selected topics from modern physics.
Interdisciplinary Option: Forensic Science
Course equivalencies: PHYS112/PHYS112K/PHYS122
Outcomes:
Understand and apply electromagnetism to 2- and 3-dimensional problems in physical and biological sciences

PHYS 112L College Physics Lab II (1 Credit Hour)
Pre-requisites: PHYS 112 or PHYS 122 (may also be taken as corequisite); also prerequisite PHYS 111L; For ESBE, ESCE, and ESEE majors only: Prerequisite or corequisite of PHYS 122
Laboratories cover selected topics in electrical circuits and optics, including DC circuits, resonance in AC circuits, ray optics, and prism and grating spectrometers.
Interdisciplinary Option: Forensic Science
Outcomes:
Understand the connection between theory and experiment for selected topics in elementary electrical circuits and optics; Experience and familiarity with DC power supplies, digital multi-meters, function generators, oscilloscopes, mirrors, lenses, and spectrometers; Ability to correlate simple electronic schematic diagrams with actual circuits

PHYS 121 College Physics I with Calculus Lecture/Discussion (3 Credit Hours)
Co-requisites: MATH 131 or MATH 161
Calculus-based introduction to vectors, kinematics, Newtonian mechanics of translational, rotational, and oscillatory motion, energy and momentum conservation, and thermodynamics.
Interdisciplinary Option: Forensic Science
Outcomes:
Understanding of analytical description of motion and application of conservation laws; develop scientific insight and proficiency in solving representative problems

PHYS 122 College Physics II with Calculus Lecture/Discussion (3 Credit Hours)
Pre-requisites: PHYS 121; Corequisite: MATH 132 or MATH 162
Calculus-based introduction to electricity and magnetism, sound, optics, and selected topics from modern physics.
Interdisciplinary Option: Forensic Science
Course equivalencies: PHYS112/PHYS112K/PHYS122
Outcomes:
Understand and apply electromagnetism to 2- and 3-dimensional problems in physical and biological sciences

PHYS 126F Freshman Projects (1 Credit Hour)
Pre-requisites: PHYS 111 or 121 (C- or better); Enrollment restricted to PHYS, BPHY, TPAM, and PCSC majors Outcomes: Students should gain a deeper understanding of the material covered in introductory physics and learn about research methods employed by physicists
Under the guidance of a faculty member, students perform research on a physics-related topic through a semester-long project. The project involves development of a proposal, building of experimental apparatus, data collection/analysis, and theoretical calculations.
This course satisfies the Engaged Learning requirement.

PHYS 130 Introduction to Computational Physics (3 Credit Hours)
Pre-requisites: PHYS 121 (C- or better); Corequisite: PHYS 122
This is an introductory computational physics course. The course will cover basic computational skills using Python and common scientific Python packages. We will solve a set of programming exercises that enhances both the understanding of introductory physics (Newton's laws, work, energy, momentum) and physics problem solving skills.
Outcomes:
Students should be able to write a Python program to perform numerical calculations in physics and gain computational skills that would be utilized in upper division physics coursework and research

PHYS 235 Modern Physics (3 Credit Hours)
Pre-requisites: PHYS 122 (C- or better); Corequisites: PHYS 235L and MATH 263; Enrollment is restricted to PHYS, BPHY, TPAM and PCSC majors and PHYS minors
This course covers the Special Theory of Relativity and Introductory Quantum Mechanics.
Outcomes:
Understand the relative nature of space and time; the duality of waves and particles; the microscopic structure of matter and its macroscopic consequences

PHYS 235L Modern Physics Laboratory (1 Credit Hour)
Co-requisites: PHYS 235
Modern physics experiments including electromagnetic waves (microwaves), interferometry, spectroscopy, electron and quantum physics, and solid-state physics.
Outcomes:
Students will gain hands on experience and familiarity with experiments from early modern physics, the ability to use spreadsheets and symbolic algebraic software for problem solving and data interpretation, and experience documenting and reporting results including historical background searches

PHYS 301 Mathematical Methods in Physics (3 Credit Hours)
Pre-requisites: PHYS 235; Corequisite: MATH 264
Lecture and computer laboratory; Mathematical and computer methods in physics and engineering; Topics include vector calculus, functions of a complex variable, phasors, Fourier analysis, linear transformations, matrices, first and second order differential equations, special functions, numerical and symbolic computer applications.
Course equivalencies: X-PHYS301/PHYS271/MATH355

PHYS 303 Electronics I (3 Credit Hours)
Pre-requisites: PHYS 122 (C- or better); Corequisite: PHYS 303L; Enrollment restricted to PHYS, BPHY, TPAM, PCSC majors and PHYS minors
Study of analog electronics, including direct and alternating circuit analysis, resonant circuits, diodes, transistors, amplifiers, operational amplifiers, noise, feedback and oscillators.
Outcomes:
Students will understand and manipulate equations and concepts, and gain experience with electronics equipment, plotting and interpretation of data, synthesizing and writing laboratory results, and the formal verbal presentation of results

PHYS 303L Electronics Laboratory (1 Credit Hour)
Pre-requisites: PHYS 122 (C- or better); Corequisite: PHYS 303; Enrollment restricted to PHYS, BPHY, TPAM, PCSC majors and PHYS minors
Students will learn to use various electronic components, instruments, techniques, and applications. This course is the lab component for PHYS 303.
Outcomes:
Students should get a deeper understanding of the material covered in PHYS 303 (Analog and digital electronics) by experimentally verifying many of the concepts covered in that course; Students will also learn to recognize various components and develop confidence in using them

PHYS 310 Optics (3 Credit Hours)
Pre-requisites: PHYS 235 (C- or better); Corequisite: PHYS 310L; Enrollment restricted to PHYS, BPHY, TPAM, PCSC majors and PHYS minors
The course covers electromagnetic nature of light, geometrical optics, polarization, Fresnel relations, interference, Fraunhofer and Fresnel diffraction, Fourier optics, lasers, and holography.
Outcomes:
Students will gain knowledge of the principles of classical and modern optics, the role of optics in the development of quantum mechanics and its applications to modern technology

PHYS 310L Optics Lab (1 Credit Hour)
Pre-requisites: PHYS 235 (C- or better); Corequisite: PHYS 310; Enrollment restricted to PHYS, BPHY, TPAM, PCSC majors and PHYS minors
Students will learn to use various optical components, instruments, techniques, and applications. This course is the lab component to PHYS 310.
Outcomes:
Students should get a deeper understanding of the material covered in PHYS 310 (Geometrical and wave optics) by experimentally verifying many of the concepts covered in that course; Students will also learn to recognize various components and develop confidence in using them

PHYS 314 Theoretical Mechanics I (3 Credit Hours)
Pre-requisites: PHYS 122 (C- or better); Corequisites: MATH 264 and PHYS 301 Outcomes: Students will gain understanding of analytical and numerical methods of mechanics, understanding of principles in dynamics, and experience in applying formalisms of Lagrange and Hamilton to mechanics in preparation for other areas of physics and engineering
Newtonian particle dynamics, conservation theorems, oscillations, gravitation, generalized coordinates, Lagrange and Hamilton formalisms.

PHYS 315 Theoretical Mechanics II (3 Credit Hours)
Pre-requisites: PHYS 314
This course is a continuation of PHYS 314 and covers dynamics of system of particles, moving coordinates, rigid body dynamics, systems of oscillators, motion in a central force field, relativity.
Outcomes:
Students will gain understanding of analytical and numerical methods of mechanics, and of the laws of dynamics and their applications

PHYS 328 Thermal Physical & Statistical Mechanics (3 Credit Hours)
Pre-requisites: PHYS 235 and PHYS 301
This course examines the fundamental concepts of temperature, entropy, and thermodynamic equilibrium, the first and second law, engines, the third law, and Boltzmann, Fermi-Dirac, and Bose-Einstein statistics.
Outcomes:
Students will learn to compare thermodynamical versus statistical characterizations of macroscopic systems with applications ranging from analyzing Fermi gases and black body radiation to information theory

PHYS 338 Advanced Physics Laboratory (2 Credit Hours)
Pre-requisites: PHYS 301 and PHYS 314; Restricted to PHYS, TPAM, PCSC, and BPHY majors
Lab course with advanced experiments in mechanics, biophysics, electromagnetism, quantum mechanics, solid state, and particle physics. Students will receive training in data analysis methods, data acquisition systems, signal processing, and 3D fabrication. Students will work in teams on a final independent project.
This course satisfies the Engaged Learning requirement.
Outcomes:
Students will gain an understanding of experiment design, data analysis, and error estimation in the context of investigating physical principles and using different instrumentation

PHYS 351 Electricity and Magnetism I (3 Credit Hours)
Pre-requisites: PHYS 235, 301 & MATH 264
Electrostatics and magnetostatics in a vacuum as well as in linear media, and an introduction to electrodynamics.
Outcomes:
Students will gain an understanding of mathematical methods of electrodynamics, of static electricity and magnetism including Coulomb's, Gauss', Ampere's, and Faraday's laws and their applications, and of solutions of Laplace's and Maxwell's equations

PHYS 352 Electricity and Magnetism II (3 Credit Hours)
Pre-requisites: PHYS 351
Introduction to electrodynamics and the special theory of relativity.
Outcomes:
Students will gain an understanding of electromagnetic field energy and momentum, Maxwell's equations and their applications including electromagnetic radiation and emission, involving retarded potentials and Lorentz covariance

PHYS 361 Quantum Mechanics I (3 Credit Hours)
Pre-requisites: PHYS 235 & PHYS 301
Non-relativistic quantum mechanics.
Outcomes:
Students will understand and use separation of variables, finite polynomials, and matrix algebra to solve the Schroedinger equation, explain microscopic structure of matter, and describe philosophical interpretations of quantum mechanics

PHYS 371 Biophysics (3 Credit Hours)
Pre-requisites: For Biology and Molecular Biology majors: BIOL 251, (PHYS 112 or 122), and (MATH 132 or 162); For all other majors: PHYS 235 and BIOL 101
An upper-level course in biological physics focused on a quantitative description of the physical processes driving molecular and cellular processes with an emphasis on experiment design and analysis.
Outcomes:
Students will understand how to apply physical principles and probabilistic analysis toward the study of biological phenomena at molecular and cellular levels

PHYS 380 Special Topics in Physics (1-3 Credit Hours)
Pre-requisites: Instructor's permission
This variable (1-3) credit enrichment course introduces students to a topic not generally covered in other courses. This course can be repeated.
Outcomes:
Students will understand the material of the course and develop an ability to apply the knowledge gained to other contexts

PHYS 381 Special Topics in Physics (1-3 Credit Hours)
Pre-requisites: Instructor's permission
This variable (1-3) credit enrichment course introduces students to a topic not generally covered in other courses. This course can be repeated.
Outcomes:
Students understand the material of the course and develop an ability to apply the knowledge gained to other contexts

PHYS 391 Research (1-12 Credit Hours)
Research in physics or an associated field. This is a variable credit course and can be repeated.
This course satisfies the Engaged Learning requirement.
Course equivalencies: PHYS391 / PHYS385 / PHYS386
Outcomes:
Under the guidance of a faculty member, students study and understand research methods employed by physicists and gain a deeper understanding of a particular area of physics

PHYS 394 Argonne Lab Research (3 Credit Hours)
Pre-requisites: Chairperson's permission and acceptance by appropriate program
Study and research at the Argonne National Laboratory. Only those students who are accepted into the Argonne National Laboratory's student program (or similar programs elsewhere) are eligible. No tuition is charged.
Outcomes:
Students will work with a research group at Argonne or other laboratory to understand research methods employed by physicists and get a deeper understanding of a particular area of physics

PHYS 395 Argonne Lab Research (3 Credit Hours)
Pre-requisites: Chairperson's permission and acceptance by appropriate program
Study and research at the Argonne National Laboratory. Only those students who are accepted into the Argonne National Laboratory's student program (or similar programs elsewhere) are eligible. No tuition is charged.
Outcomes:
Students will work with a research group at Argonne or other laboratory to understand research methods employed by physicists and get a deeper understanding of a particular area of physics