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/Secondary Education (BS/MEd) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/physics-secondary-education-bs-med/)
- Physics with Computer Science (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/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 Lec/Dis and PHYS 122 College Physics II Lec/Dis 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/undergraduate-academic-standards-regulations/) 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 ENVS 137
No requirement for students with a declared major or minor in the Department of Anthropology, Department of Biology, Department of Chemistry, Department of Environmental Science, Department of Physics, Bioinformatics, Forensic Science or Neuroscience. 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 101T Tutoring for Physics 101 - NO CREDIT (0 Credit Hours)**
Tutoring for Physics 101 - NO CREDIT

#### PHYS 102 Planetary and Stellar Astronomy (3 Credit Hours)
**Pre-requisites:** ENVS 101 or ENVS 137
No requirement for students with a declared major or minor in the Department of Anthropology, Department of Biology, Department of Chemistry, Department of Environmental Science, Department of Physics, Bioinformatics, Forensic Science or Neuroscience. 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 ENVS 137
No requirement for students with a declared major or minor in the Department of Anthropology, Department of Biology, Department of Chemistry, Department of Environmental Science, Department of Physics, Bioinformatics, Forensic Science or Neuroscience. 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
No course description is available
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)
Prerequisite or Corequisite PHYS 111 or PHYS 111K. 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 111T Tutoring for Physics 111 - NO CREDIT (0 Credit Hours)
Tutoring for Physics 111 - NO CREDIT

PHYS 112 College Physics II Lec/Disc (3 Credit Hours)
Pre-requisites: Physics 111 or equivalent
Physics 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)
Prerequisite or co-requisite: PHYS 112 or PHYS 112K; also prerequisite PHYS 111L. For ESBE, ESCE, and ESEE majors only. Prerequisite or corequisite of PHYS 112K 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:
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; Understand the connection between theory and experiment for selected topics in elementary electrical circuits and optics

PHYS 112T Tutoring for Physics 112 - NO CREDIT (0 Credit Hours)
Tutoring for Physics 112 - NO CREDIT

PHYS 121 College Physics I Lec/Dis (3 Credit Hours)
Pre-requisites: MATH 131 or 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 Phys II Lec/Dis (3 Credit Hours)
Pre-requisites: PHYS 121 and (MATH 132 or 162)
Physics 121 and 122 provide a calculus based 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 125 General Physics I Lec/Dis (4 Credit Hours)
Co-requisites: PHYS 125L and MATH 161 This is a calculus-based introductory course that covers Mechanics and Thermodynamics
It is designed for physics majors or minors and dual-degree engineering students.
Interdisciplinary Option: Forensic Science
Outcomes:
Understanding of vectors, forces, Newtonian mechanics related to translational, rotational, and oscillatory motion; thermodynamics

PHYS 125L General Physics Laboratory I (1 Credit Hour)
Co-requisites: PHYS 125 Laboratories cover selected topics in introductory mechanics, including freefall, uniform circular motion, work-energy, collisions, rotational motion, and harmonic motion Includes a freshmen project.
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 126 General Physics II Lec/Dis (3 Credit Hours)
Pre-requisites: PHYS 125 Corequisites: PHYS 126F, PHYS 126L & MATH 162. A continuation of PHYS 125, covering Electricity and magnetism, sound, optics
Department Consent Required
Interdisciplinary Option: Forensic Science
This course satisfies the Engaged Learning requirement.
Outcomes:
Understanding of electrostatics, magnetostatics, time varying currents, resistive, capacitative and inductive elements, electromagnetic and sound waves, geometrical and wave optics, introductory special relativity

PHYS 126F Freshman Projects (1 Credit Hour)
Pre-requisites: PHYS 125 Under the guidance of a faculty member students carry out research in the area of mechanics, waves or thermodynamics
Department Consent Required
The project must involve submission of a proposal, building of a setup, carrying out related theoretical calculation followed by experimentation.
This course satisfies the Engaged Learning requirement.
Outcomes:
Students should get a deeper understanding of the material covered in PHYS 125 (mechanics, waves and thermodynamics) and also learn about research methods employed by physicists

PHYS 126L General Physics Laboratory II (1 Credit Hour)
Co-requisites: PHYS 126 Laboratories cover selected topics in electrical circuits and optics, including DC circuits, resonance in AC circuits, ray optics, and prism and grating spectrometers
Includes a freshmen project.
Interdisciplinary Option: Forensic Science
Outcomes:
Experience and familiarity with DC power supplies, digital multimeters, function generators, oscilloscopes, mirrors, lenses, and spectrometers; Ability to correlate simple electronic schematic diagrams with actual circuits; Understand the connection between theory and experiment for selected topics in elementary electrical circuits and optics

PHYS 130 Introduction to Computational Physics (3 Credit Hours)
Pre-requisites: C- or better in PHYS 125; Restricted to PHYS, TPAM, and BPHY majors
Corequisite: PHYS 126
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
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.

PHYS 235 Modern Physics (3 Credit Hours)
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
No course description is available
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 266 Digital Electronics Lab (3 Credit Hours)
Pre-requisites: PHYS 126 and MATH 162
Combinaitorial and sequential logic devices, oscillators and timers, microprocessor components, CPU operation, computer architecture and digital/analog conversion
Description:
Course equivalencies: X-PHYS266/COMP266
Outcomes:
Students will gain a working knowledge of digital electronics design and its application to computers, an understanding of CPU design and operation and the ability to document and report experimental results

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
No course description is available
Course equivalencies: X-PHYS301/PHYS271/MATH355

PHYS 303 Electronics I (3 Credit Hours)
Pre-requisites: PHYS 126 Corequisite: PHYS 301 and PHYS 303L
Study of analog electronics, including direct and alternating circuit analysis, resonant circuits, diodes, transistors, amplifiers, operational amplifiers, noise, feedback and oscillators
No course description is available
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 126 or its equivalent, Co-requisite PHYS 303
Students will learn to use various electronic components, instruments, techniques, and applications. This course complements PHYS 303, which is a co-requisite or a prerequisite.
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 126 & PHYS 301 Co-requisite: PHYS 310L*
Electromagnetic nature of light, geometrical optics, polarization, Fresnel relations, interference, Fraunhofer and Fresnel diffraction, Fourier optics, lasers, and holography
No course description is available
*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 126 or its equivalent, Co-requisite PHYS 310*
Students will learn to use various optical components, instruments, techniques, and applications. This course complements PHYS 310, which is a co-requisite or a prerequisite.
*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)**
Newtonian particle dynamics, conservation theorems, oscillations, gravitation, generalized coordinates, Lagrange and Hamilton formalisms.
*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

**PHYS 315 Theoretical Mechanics II (3 Credit Hours)**
*Pre-requisites: PHYS 314 This course is a continuation of Physics 314 and covers dynamics of system of particles, moving coordinates, rigid body dynamics, systems of oscillators, motion in a central force field, relativity*
No course description is available
*Outcomes:*
Students will gain understanding of analytical and numerical methods of mechanics, and of the laws of dynamics and their applications

**PHYS 328 Thermal Phys & Stat 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*
No course description is available
*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*
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. Restricted to PHYS, TPAM, PCSC, and BPHY majors
*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*
No course description is available
*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 356 Quantum Mechanics I (3 Credit Hours)**
*Pre-requisites: PHYS 235 & PHYS 301 Non-relativistic quantum mechanics*
No course description is available
*Outcomes:*
Students will understand how to apply physical principles and probabilistic analysis toward the study of biological phenomena at molecular and cellular levels

**PHYS 371 Biophysics (3 Credit Hours)**
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.
*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.*
*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)
Co-requisites: PHYS 126 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