PHYSICS

Physics is the study of the fundamental laws that govern our universe. Our curriculum is designed to give our students a solid foundation for understanding these laws and how they were uncovered. The language that best expresses these laws is mathematical, so there are a significant number of mathematics courses that serve as prerequisites for our courses. However, since physics describes the real world, our curriculum also incorporates a significant laboratory component to ensure our students will learn how to interrogate Nature and understand the answers it gives. Only by balancing theoretical concepts with experimental reality can one reach a more complete understanding of the world. Finally, our students learn to use computers to solve difficult problems, collect and analyze data, and effectively present the results of their work.

Our physics majors and minors will master valuable analysis, problem-solving, computational, and communication skills, which can be applied to a wide variety of situations beyond physics. By integrating these skills with their liberal arts experiences, our students are prepared for a vast spectrum of careers. Recent graduates have gone on to work in physics research, engineering, computer science, teaching, environmental studies, law, business, and other fields.

For Senior Comprehensives

Majors must pass a multi-part exam which requires them to demonstrate a coherent understanding of all the major areas of physics covered in the required courses, including computational and laboratory methods, and the ability to apply this understanding to solve specific problems. Students must have completed PHY-111 Physics I - Calculus, PHY-112 Physics II - Calculus, PHY-209 Intro Thermal Phy & Relativity, PHY-210 Intro Quantum Theory & Apps, PHY-381 Advanced Laboratory I, and two out of the three 300-level theory courses (PHY-310 Classical Mechanics, PHY-314 Electromagnetic Theory, PHY-315 Quantum Mechanics) prior to taking the exam. Additionally, student portfolios will be utilized as part of the assessment of the comprehensive exams.

Student Learning Goals

Core Knowledge and Concepts: Students should acquire a functional understanding of the fundamental laws and conceptual framework of classical mechanics, electromagnetism, waves and optics, special relativity, thermal physics, and quantum mechanics.

Connecting and Broadening: Students should gain an appreciation of the many applications of physics while making connections between the core subject areas.

Problem Solving: Students should develop expert-like problem-solving skills.

Laboratory Skills: Students should develop the ability to design and conduct experiments to explore physical questions.

Computational Skills: Students should develop the ability to use computer software to write programs to solve problems that are not amenable to analytic solutions and to gain conceptual understanding through graphical representations and animations.

Communication Skills: Students should be able to communicate their understanding of technical issues to an audience in written, oral, and visual forms.

Research Skills: Students should be able to address problems for which there is no known solution.

Group Skills: Students should be able to work effectively in groups to solve problems.

Physics and Society: Students should be able to describe the role physics plays in our daily lives and in addressing the major problems of the world.

Historical Perspective: Students should be able to explain how our present understanding of physics came about and by whom, how the demographics of the physics community have an impact on society, and how certain groups had been excluded in the past.

Future Direction: Students should develop a plan of what they will do after they leave Wabash.

Requirements for a Major

Code	Title	Credits
PHY-111	Physics I - Calculus	1
PHY-112	Physics II - Calculus	1
PHY-209	Intro Thermal Phy & Relativity	1
PHY-210	Intro Quantum Theory & Apps	1
PHY-381	Advanced Laboratory I	0.5
PHY-382	Advanced Laboratory II	0.5
PHY-400	Senior Seminar	0.5
Select two from the following:		2
PHY-310	Classical Mechanics	
PHY-314	Electromagnetic Theory	
PHY-315	Quantum Mechanics	
Physics Electives		1.5
Total Credits		**9**

Majors will also be required to maintain a portfolio of their work from courses, internships, and other work outside of class. (More information on portfolios can be found on the Physics Department Canvas page). Evaluation of portfolios will be an aspect of the comprehensive exams for the physics major. In addition, mathematics courses that are prerequisites or co-requisites for physics courses are the following:

Code	Title	Credits
Collateral Requirements		
MAT-111	Calculus I	1
MAT-112	Calculus II	1
MAT-223	Linear Algebra	1
MAT-224	Differential Equations	1
MAT-225	Multivariable Calculus	1
Total Credits		**5**

PHY-101 Astronomy, PHY-104 Special Topics, PHY-105 Adventures in Physics, PHY-109 Physics I - Algebra, and PHY-110 Physics II - Algebra do not count toward the major unless supplemented by additional work that must receive prior approval by the course instructor and the physics department chair. Students accepted into a 3-2 engineering program may substitute CHE-111 General Chemistry for the one elective physics course. Although not required, CSC-111 Intro to

Programming is highly recommended, and MAT-324 Topics in Differential Equations and MAT-344 Complex Analysis are useful.

Those planning to go on to graduate school in physics should plan to take the following:

Code	Title	Credits
PHY-230	Thermal and Statistical Physics	1
PHY-310	Classical Mechanics	1
PHY-314	Electromagnetic Theory	1
PHY-315	Quantum Mechanics	1
Total Credits		**4**

Since physics is a hierarchical subject, it is important to take PHY-111 Physics I - Calculus and PHY-112 Physics II - Calculus during the freshman year if one wishes to major in physics. The hierarchical nature of the discipline requires mastery of each course's material prior to moving on to the next course in the sequence, and many courses therefore require a C- or better in prerequisite courses. A possible schedule to fulfill all of the necessary requirements:

Course	Title	Credits
Freshman		
Fall Semester		
PHY-111	Physics I - Calculus	1
MAT-111	Calculus I	1
	Credits	**2**
Spring Semester		
PHY-112	Physics II - Calculus	1
MAT-112	Calculus II	1
	Credits	**2**
Sophomore		
Fall Semester		
PHY-209	Intro Thermal Phy & Relativity	1
MAT-223	Linear Algebra	1
	Credits	**2**
Spring Semester		
PHY-210	Intro Quantum Theory & Apps	1
MAT-224	Differential Equations	1
	Credits	**2**
Junior		
Fall Semester		
PHY elective		1
PHY-381	Advanced Laboratory I	0.5
MAT-225	Multivariable Calculus	1
	Credits	**2.5**
Spring Semester		
PHY elective		1
	Credits	**1**
Senior		
Fall Semester		
PHY elective		1
PHY-382	Advanced Laboratory II	0.5
PHY-400	Senior Seminar	0.5
	Credits	**2**
Spring Semester		
PHY elective		0.5
	Credits	**0.5**
	Total Credits	**14**

300-level elective courses regularly offered in the fall semester are PHY-310 Classical Mechanics, PHY-315 Quantum Mechanics, while PHY-314 Electromagnetic Theory is taught in the spring semester. In addition, PHY-220 Electronics and PHY-230 Thermal and Statistical Physics are usually taught in alternate years.

The Physics Department will not accept a transfer credit for PHY-111 Physics I - Calculus as a prerequisite to the College's PHY-112 Physics II - Calculus unless approval is received by a department chair.

Requirements for a Minor

Code	Title	Credits
PHY-111	Physics I - Calculus	1
PHY-112	Physics II - Calculus	1
PHY-209	Intro Thermal Phy & Relativity	1
PHY-210	Intro Quantum Theory & Apps	1
Physics Elective		1
Total Credits		**5**

Any exceptions must receive prior approval from the department chair. PHY-101 Astronomy, PHY-104 Special Topics, PHY-105 Adventures in Physics, PHY-109 Physics I - Algebra, and PHY-110 Physics II - Algebra do not count toward the minor unless supplemented by additional work that must receive prior approval by the course instructor and the physics department chair. Mathematics prerequisites (or co-requisites) are MAT-111 Calculus I and MAT-112 Calculus II.

PHY-101 Astronomy
An introductory course intended for the non-science liberal arts student. Historical and philosophical ideas will be stressed as well as the experimental concepts and methods used in astronomy. A good working knowledge of algebra, plane geometry, and trigonometry is required. Satisfies half of the laboratory science requirement. Three class periods and one laboratory each week.
Prerequisites: none
Corequisites: PHY-101L
Credit: 1
Distribution: Science Lab, Quantitative Literacy

PHY-104 Special Topics
A special interest course for the non-science liberal arts student on an introductory-level physics topic not covered in a regular physics course. (Does not count toward the major or minor, or the lab science requirement.) Topics vary with each scheduled offering. Refer to Student Planning's section information for descriptions of individual offerings, and applicability to distribution requirements.
Prerequisites: none
Credits: 0.5-1

PHY-105 Adventures in Physics
A one-semester course for the non-science liberal arts student that investigates the world from the viewpoint of a physicist. Topics will vary and will be announced prior to registration. Partially fulfills the college laboratory science requirement, but does not count toward a physics major or minor. Three class periods and one laboratory each week.
Prerequisites: none
Corequisites: PHY-105L
Credit: 1

PHY-109 Physics I - Algebra
An introduction to the study of motion and waves; topics include Newton's laws, energy and work, periodic motion and feedback, sound and light waves, and optics. These topics are especially relevant for students interested in pre? health. The lab activities will introduce measurement techniques and will emphasize understanding the limits to any measurement. Three class periods and one lab period each week. Partially fulfills the college laboratory science requirement, and may count toward a physics major or minor with department permission. This course is typically offered in the fall semester. Not available to students who have received credit for PHY-111. Also not available to students who have taken or been placed in MAT-112 without instructor permission.
Prerequisites: none
Corequisites: PHY-109L
Credit: 1
Distribution: Science Lab, Quantitative Literacy

PHY-110 Physics II - Algebra
An algebra-based introduction to electricity and magnetism for general audiences, including the social and life sciences. Topics include Coulombs law, electric circuits, magnetic fields, electromagnetic induction, and geometric optics. The lab will introduce data acquisition and analysis techniques. Three class periods and one laboratory each week. Not available to students who have taken PHY-111 without Instructor permission.
Prerequisites: PHY-109 or PHY-111, or approval of instructor
Corequisites: PHY-110L
Credit: 1
Distribution: Science Lab, Quantitative Literacy

PHY-111 Physics I - Calculus
A calculus-based introduction to classical mechanics forphysics, chemistry, and engineering. Topics include Newton's laws of motion, conservation laws, and rotational dynamics. The lab will introduce data acquisition and analysis techniques. Three class periods and one laboratory each week.
Prerequisites: MAT-110 or MAT-111, or placement into MAT-111 with concurrent registration, or placement into MAT-112 or MAT-223
Corequisites: PHY-111L
Credit: 1
Distribution: Science Lab, Quantitative Literacy

PHY-112 Physics II - Calculus
An introduction to the fundamental concepts concerning fluids, waves, optics, electricity, and magnetism. Three class periods and one laboratory each week. This course is offered in the spring semester.
Prerequisites: PHY-111 with a minimum grade of C-
Corequisites: PHY-112L
Credit: 1
Distribution: Science Lab, Quantitative Literacy

PHY-177 Special Topics
This course is offered in the fall semester. Topics vary with each scheduled offering. Refer to Student Planning's section information for descriptions of individual offerings, and applicability to distribution requirements.
Prerequisites: none
Credits: 0.5-1

PHY-178 Special Topics
This course is offered in the spring semester. Topics vary with each scheduled offering. Refer to Student Planning's section information for descriptions of individual offerings, and applicability to distribution requirements.
Prerequisites: none
Credits: 0.5-1

PHY-187 Independent Study
Individual research projects. The manner of study will be determined by the student in consultation with the instructor. Students must receive written approval of their project proposal from a department Chair before registering for the course.
Prerequisites: none
Credits: 0.5-1

PHY-188 Independent Study
Individual research projects. The manner of study will be determined by the student in consultation with the instructor. Students must receive written approval of their project proposal from a department Chair before registering for the course.
Prerequisites: none
Credits: 0.5-1

PHY-209 Intro Thermal Phy & Relativity
An introduction to thermal physics and special relativity. Topics include the laws of thermodynamics, statistical nature of entropy, Lorentz transformations, equivalence of mass and energy. The lab will introduce the methodology of experimental design, numerical techniques for solving differential equations, and the writing of scientific papers using LaTeX software. Three class periods and one laboratory each week. This course is offered in the fall semester.
Prerequisites: PHY-112 with a minimum grade of C-, and MAT-112
Corequisites: PHY-209L
Credit: 1
Distribution: Quantitative Literacy, Science Lab

PHY-210 Intro Quantum Theory & Apps
An introduction to quantum theory with applications to atomic, solid state, nuclear, and particle physics. Three class periods and one laboratory each week. This course is offered in the spring semester.
Prerequisites: PHY-209 with a minimum grade of C-, and MAT-223
Corequisites: PHY-210L
Credit: 1
Distribution: Science Lab, Quantitative Literacy
Equated Courses: CR

PHY-220 Electronics
Introduction to analog and digital electronics. Fundamentals of DC and AC circuits, transistors, and amplifiers will be covered. Includes one laboratory each week.
Prerequisites: PHY-112 with a minimum grade of C-
Corequisites: PHY-220L
Credit: 1
Distribution: Science Lab, Quantitative Literacy

PHY-230 Thermal and Statistical Physics
Introduction to thermal and statistical physics. The laws of thermodynamics are studied from microscopic and macroscopic perspectives. Quantum statistical mechanics will be developed and applied to blackbody radiation, fermionic and bosonic systems.
Prerequisites: PHY-210 with a minimum grade of C-
Credit: 1
Distribution: Quantitative Literacy

PHY-235 Stochastic Simulation
Interesting real world phenomena often involve randomness at some level, and this course develops mathematical and computational tools for studying these systems. In particular, students will study and implement computer simulation models of continuous and discrete stochastic processes with potential applications in physics, economics, epidemiology, networks, sports, elections, and industrial engineering. Specific topics for study include: basic probability models, pseudo-random number generation, queueing models, discrete event simulations, Poisson processes, random walks, Markov chains, Monte Carlo methods, and statistical analysis of simulated data.
Prerequisites: MAT-112 and CSC-111
Credit: 1

PHY-277 Special Topics
Topics vary with each scheduled offering. Refer to Student Planning's section information for descriptions of individual offerings, and applicability to distribution requirements.
Prerequisites: none
Credits: 0.5-1

PHY-278 Special Topics
This course is offered in the spring semester. Topics vary with each scheduled offering. Refer to Student Planning's section information for descriptions of individual offerings, and applicability to distribution requirements.
Prerequisites: none
Credits: 0.5-1

PHY-287 Independent Study
Individual research projects. The manner of study will be determined by the student in consultation with the instructor. Students must receive written approval of their project proposal from a department Chair before registering for the course.
Prerequisites: none
Credits: 0.5-1

PHY-288 Independent Study
Individual research projects. The manner of study will be determined by the student in consultation with the instructor. Students must receive written approval of their project proposal from a department Chair before registering for the course.
Prerequisites: none
Credits: 0.5-1

PHY-302 Electron Microscopy
Electron microscopes employ a focused beam of highly energetic electrons to examine sample morphology and topography on a very fine scale. This information is essential to the characterization of a wide range of biological and inorganic specimens including microorganisms, cells, crystals, metals, microelectronics, and nanomaterials. The initial classroom portion of this course focuses on fundamental topics in instrument design, applications, limitations, and sample preparation methods. Subsequent laboratory work involves hands-on instrument training and a substantial microscopy project.
Prerequisites: none
Credit: 1
Equated Courses: CHE-302

PHY-310 Classical Mechanics
Advanced topics in classical mechanics, including harmonic motion and Lagrangian mechanics.
Prerequisites: PHY-112 with a minimum grade of C- and MAT-224, or permission of instructor
Credit: 1

PHY-314 Electromagnetic Theory
Advanced explorations in understanding and applying Maxwell's equations. This course is offered in the spring semester.
Prerequisites: PHY-112 with a minimum grade of C-, MAT-224, and MAT-225
Credit: 1
Distribution: Quantitative Literacy

PHY-315 Quantum Mechanics
Introduction to quantum mechanics. Topics include Dirac notation, postulates of quantum mechanics, and applications to important physical systems. This course is offered in the fall semester.
Prerequisites: PHY-210 with a minimum grade of C-, MAT-223, and MAT-224
Credit: 1
Distribution: Quantitative Literacy

PHY-377 Adv Special Topics in Physics
Special interest course covering one of a selection of advanced physics topics including: atomic physics, nuclear physics, quantum field theory, advanced electrodynamics, advanced quantum mechanics, advanced classical mechanics, or other topics proposed by students.Topics vary with each scheduled offering. Refer to Student Planning's section information for descriptions of individual offerings, and applicability to distribution requirements.
Prerequisites: PHY-210
Credits: 0.5-1

PHY-378 Adv. Special Topics in Physics
Special interest course covering one of a selection of advanced physics topics including: atomic physics, nuclear physics, quantum field theory, advanced electrodynamics, advanced quantum mechanics, advanced classical mechanics, or other topics proposed by students. This course is offered in the spring semester. Topics vary with each scheduled offering. Refer to Student Planning's section information for descriptions of individual offerings, and applicability to distribution requirements.
Prerequisites: PHY-210
Credits: 0.5-1

PHY-381 Advanced Laboratory I
Students will participate in a broad range of experiments that cover major research areas in contemporary physics, including atomic, molecular, and optical physics, condensed matter physics, and nuclear and particle physics. Advanced measurement and data analysis techniques will be used. All experiments will be planned, executed, and presented according to current professional standards. Students should take this course during their junior year.
Prerequisites: PHY-210
Credits: 0.5

PHY-382 Advanced Laboratory II
This course is an independent research project, typically a continuation of either an Advanced Laboratory I project or a summer internship research project. Typically taken in the fall semester of the senior year.
Prerequisites: PHY-381
Credits: 0.5

PHY-387 Independent Study
Individual research projects. The manner of study will be determined by the student in consultation with the instructor. Students must receive written approval of their project proposal from a department Chair before registering for the course.
Prerequisites: none
Credits: 0.5-1

PHY-388 Independent Study
Individual research projects. The manner of study will be determined by the student in consultation with the instructor. Students must receive written approval of their project proposal from a department Chair before registering for the course.
Prerequisites: none
Credits: 0.5-1

PHY-400 Senior Seminar
This course is a senior seminar course which all physics majors should take in their final year at Wabash. Course work will include reading primary literature, designing research projects to address societal issues, exploring the demographics and diversity of scientists, proposing outreach methods to make physics more inclusive, and evaluating the moral and ethical responsibilities of science. This course is offered in the fall semester
Prerequisites: PHY-210
Credits: 0.5
Distribution: Global Citizenship, Justice, and Diversity

PHY-487 Independent Study
Individual research projects. The manner of study will be determined by the student in consultation with the instructor. Students must receive written approval of their project proposal from a department Chair before registering for the course.
Prerequisites: none
Credits: 0.5-1

PHY-488 Independent Study
Individual research projects. The manner of study will be determined by the student in consultation with the instructor. Students must receive written approval of their project proposal from a department Chair before registering for the course.
Prerequisites: none
Credits: 0.5-1

Physics Faculty

James A Brown

Dennis Krause (chair)

James Gaylon Ross

Nathan Tompkins, *Sabbatical*