PHYSICS MAJOR

MAJOR DESCRIPTION

The Major in Physics equips students with an understanding of the fundamental laws that shape the universe and develops the skills needed to succeed in a technology driven society. Students develop competency in the main subject areas of quantum theory, electromagnetism and optics, thermodynamics and statistical mechanics, classical dynamics, and condensed matter physics. Preparation in mathematical and computational methods is an integral part of the program. Students are encouraged to consider faculty-mentored research, working collaboratively with other undergraduate and graduate students. Additionally, opportunities are available to work as a teaching assistant and to pursue advanced coursework in graduate courses.

The model Physics student is insatiably curious about the workings of the universe and has a healthy intellectual humility that enables them to learn through investigation. Students conduct experiments with precision, analyze the results, critically grasp deeper concepts, and communicate complex theories and real-world applications. Physics students are encouraged to cultivate an analytical mindset, strong quantitative aptitude, and the ability to understand complex mathematical models with the ultimate goal of expanding the boundaries of human knowledge through meaningful discovery. In addition, students should develop their communication skills for both technical and lay audiences.

Armed with problem-solving skills and a deep understanding of physics principles, Physics graduates have a wide range of career options in various industries. Example career paths include research and development, engineering, data analytics, computational science, education, finance and banking, medical physics, geophysics, and environmental science.

ADMISSION TO THE MAJOR

The appropriate course for each student depends primarily on their level of preparation and previous coursework. Prospective majors should consult with a member of the Physics faculty to determine their most suitable course of study. There are four common paths into the Physics major.

1.

PHYS113 : A calculus-based introductory mechanics course requiring one semester of calculus, taken in either secondary school or in college, at or about the level of MATH121. A student who has had no calculus may take calculus during the first year, then PHYS113 in the first semester of the sophomore year, or they may take PHYS113 simultaneously with their first calculus course.

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PHYS215/PHYS219: A vailable to first-year or other students who have had both integral and differential calculus at about the level of MATH121/MATH122 and a solid course in mechanics with calculus at the level of PHYS113.

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PHYS116: Students from both of the above gateways merge into the electricity and magnetism course, PHYS116, in the spring. Students intending to major in physics should complete either track no later than the end

of their sophomore year, preferably by the end of their first year. The PHYS113/PHYS116 sequence has associated laboratory courses, PHYS123 in the fall and PHYS124 in the spring. These sections are half-credit courses associated with the lecture courses. The laboratory course PHYS124 is required to enter the major.

1.

PHYS213 : Exceptionally well-prepared students who have already mastered the material of PHYS113/PHYS116 should consult with a member of the Physics faculty to pursue this gateway to the major.

MAJOR REQUIREMENTS

The sequence of gateway courses describes the foundation for the core major courses.

By the end of sophomore year, students should complete the following courses:

PHYS113; PHYS116; MATH121; MATH122; MATH221; and MATH222. Students considering graduate work in physics should also complete PHYS213 and PHYS214 by the end of sophomore year.

Note: Completion of PHYS116 in your first year will add flexibility to planning for your major coursework.

Some advanced courses may not be offered every year, and you should plan accordingly.

To fulfill the major in physics, a student must complete eight lecture courses and two laboratory courses.

The lecture course requirements include four core physics courses which must be taken graded (A-F): PHYS213; PHYS214; PHYS316; and PHYS324. In addition, four elective lecture credits at the 200, 300, or 500 level are required. At least one of the elective courses must be a PHYS lecture course at the 300 level, usually PHYS313 or PHYS315.

The two required laboratory courses can be chosen from PHYS342, PHYS345, PHYS340, or a 1-credit research tutorial with a Physics faculty member. One of the two laboratory courses must be an advanced experimental laboratory class, currently PHYS342 or PHYS345, or an experimentally focused research tutorial.

Students planning graduate study in physics are advised to take a minimum of 14 credits at the 200 level or higher in physics, mathematics, and computer science. PHYS313, PHYS315, and PHYS358 are essential. The department strongly recommends PHYS565, MATH226, and MATH229. Graduate physics courses may be selected with permission, and experience in computer programming is extremely valuable.

Students not planning graduate study in physics and who are interested in applying their knowledge of physics to other areas of the curriculum may substitute up to two upper-level lecture courses from other departments. This must be done in consultation with the Physics Major advisor, and the selections must constitute a coherent, coordinated program of study. Substitution of more than two courses requires approval from the department. Preapproved tracks that may include electives from outside Physics are available here. (https:// www.wesleyan.edu/physics/tracksportal.html)

PHYSICS MAJOR REQUIREMENTS COURSE CODE COURSE TITLE

Gateway courses: The necessary foundation for the physics major

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PHYS113	General Physics I
PHYS116 and PHYS124	General Physics II and General Physics Laboratory II
MATH221 or MATH223	Vectors and Matrices or Linear Algebra
MATH222	Multivariable Calculus
Core Courses: Four required courses which must be taken graded (A-F)	
PHYS213	Waves and Oscillations
PHYS214 (prerequisite MATH221 or MATH223. Math requirement can be taken concurrently)	Quantum Mechanics I
PHYS324 (prerequisite PHYS124 and MATH222)	Electricity and Magnetism
PHYS316	Thermal and Statistical Physics
Electives: Four credits from the following list of lecture courses.* One of the four needs to be a 300-level physics course.	
PHYS207	Introduction to Biophysics
PHYS215 (half credit)	Special Relativity
PHYS217	Nonlinear Dynamics and Chaos
PHYS219 (half credit)	Introduction to Contemporary Physics
PHYS313	Classical Dynamics
PHYS315	Quantum Mechanics II
PHYS358 (Pre-requisite PHYS315)	Condensed Matter Physics
Laboratory Courses:** Two laboratory courses	
PHYS342 (half credit)	Experimental Optics
PHYS345 (half credit)	Electronics Lab
PHYS340 (half credit)	Computational Physics
PHYS423/PHYS424 (1 credit)	Research Seminar, Undergraduate

* It is possible for elective credits to be substituted by upper-level lecture courses in other departments. This must be done in consultation with the physics major advisor, and the selections must constitute a coherent, coordinated program of study. Preapproved tracks that satisfy the elective lecture course requirement are available.

** One of the laboratory courses must be an advanced experimental lab, currently either PHYS342 orPHYS345.

COURSES FOR NON-MAJORS

The Physics department offers two two-semester survey courses covering many of the main subject areas of physics (mechanics, electromagnetism and optics, thermodynamics, and kinetic theory):

 PHYS111/PHYS112 uses less calculus and is often the choice for students studying physics for life science applications. • PHYS113/PHYS116 uses more calculus and is the foundation for future work in physics, engineering, and related fields.

Associated laboratory courses, PHYS121/PHYS122/PHYS123/PHYS124, are also offered. Either of these two-semester course sequences (with the lab) typically satisfy the Physics requirement for admission to most schools of medicine, dentistry, or architecture. However, some graduate-level programs require a calculus-based series. It is recommended that students confirm the specific requirements with their prospective schools.

GENERAL EDUCATION

There are no General Education requirements imposed by the Physics Department for either the Physics major or honors in Physics. However, students should be aware that several forms of university honors do require completion of stage 2 general education expectations.

STUDENT LEARNING GOALS

Physics majors acquire the following knowledge and competencies:

- Application of precision and predictive mathematics to expand the description of natural phenomena
- · Observation of physical phenomena through experimentation and research
- Determining the relevant parameters to quantify a complex system
- · Open-ended problem-solving skills
- Quantum theory
- Electromagnetism and optics
- Thermodynamics
- Statistical mechanics
- Classical dynamics
- Condensed-matter physics
- Mathematical and computational methods

Students will demonstrate their knowledge and abilities through research projects, critical analysis papers, participation in class discussions and collaborative group work, and multi-media presentations. Written exams, peer review, and self-assessment will also evaluate their class performance.

STUDY ABROAD

Study abroad provides Physics majors an opportunity to gain appreciation of their potential as citizens of the world scientific community. Careful planning in

consultation with a Physics advisor is recommended to determine the optimum semester for a study abroad experience, and to ensure that requirements for the major can be fulfilled.

ADVANCED PLACEMENT

Students may receive a maximum of two AP Physics credits if they have obtained a score of 5 on the AP Physics C, Mechanics exam, or the AP Physics C, Electricity and Magnetism exam. Special regulations apply to other Physics credits. Please check with the registrar or a departmental advisor.

PRIZES

Bertman Prize - Awarded to a senior majoring in physics who emulates the qualities that made Bud Bertman a valuable friend and respected colleague, e.g., physical insight and intuition, enthusiasm, resourcefulness, perseverance, and eagerness to help others.

Van Dyke Prize - Awarded to students majoring in physical science who show outstanding academic achievement and a promise of productivity in a professional career.

Outstanding Contribution to Science Education Award - Awarded to a senior who has demonstrated exceptional skills as an undergraduate course assistant.

Johnston Prize - In recognition of those first-year students or sophomores whose performance in their first two semesters of physics shows exceptional promise.

TRANSFER CREDIT

Up to two registrar-approved outside credits for physics courses may be applied toward the Physics major from another institution. Prior permission must be obtained from both your Physics advisor and the departmental liaison, Professor Brian Stewart (bstewart@wesleyan.edu), to ensure the creditability of the specific courses.

RELATED PROGRAMS OR CERTIFICATES

Dual-degree programs in science and engineering.

Wesleyan maintains dual-degree programs with Columbia University, the California Institute of Technology, and Dartmouth College for students wishing to combine the study of engineering with a broad background in the liberal arts. For all options, participating students receive two degrees: a BA from Wesleyan and a BS or BE in engineering from our partner school.

The "3-2 program": Students spend their first three years at Wesleyan, followed by two years at the engineering school. At the end of the fifth year —after completing all degree requirements from both schools—students receive the two bachelor's degrees. During the first three years, prospective 3-2 students complete the minimal requirements of their elected Wesleyan major and, in addition, fulfill science and mathematics requirements for the first two years of the engineering school and engineering major of their choice. During the two years at the engineering school, students follow the regular third- and fourth-year curriculum in their selected engineering field. During that time, other courses may also be taken to satisfy the degree requirements of Wesleyan and/or the engineering school.

- The "4-2 option," offered by Columbia University. Students complete four years at Wesleyan before pursuing an engineering degree.
- The "2-1-1-1" option is offered by Dartmouth University. Students spend their junior year at Dartmouth, returning to Wesleyan for their senior year and graduation. A fifth year is at Dartmouth required to finish their engineering degree.

Contact the dual-degree advisor for further information and consult with your class dean to ensure that you can meet all Wesleyan University requirements for graduation.

ADDITIONAL INFORMATION

The Physics department encourages students to become creators of physics knowledge through faculty-mentored research or by arranging independent research tutorials. Research can be experimental or theoretical and may culminate in a senior honors thesis or a peer-reviewed publication. Students planning to write a senior thesis should begin research no later than their junior year and continue through the summer into their senior year. Faculty research expertise includes quantum computing, soft condensed matter physics, computational materials science, charge transport in photovoltaic devices, fluid dynamics, laser plasmas, spectroscopy, collision studies of excited atoms and molecules, wave transport, and photonics. Many students also utilize Wesleyan's shared high-performance computing facilities for their research.

Opportunities are also available to serve as a teaching apprentice or course assistant, which many students find to be a stimulating way to improve their understanding of physics fundamentals. Serving as a course assistant is also an excellent opportunity to develop communication skills and learn the art of teaching.

The Cady Lounge provides a community space where students can study, discuss physics, and connect with peers. Additionally, there is a study area in the science library (the "STEM zone") where students in introductory courses can get help and collaborate.

Colloquia: This seminar series features distinguished scientists from other institutions who present lectures on their research findings. Seminars are usually held on Thursdays at noon in Exley 058 and are open to all members of the university community. Students may enroll in the colloquium course for credit.

Topical Seminars: The department hosts weekly seminars highlighting cuttingedge research in various areas, including condensed matter physics and atomic and molecular physics. These seminars include student-led research presentations, discussions of recent research literature, and advanced topics selected collaboratively by faculty and students.

Society of Physics Students (SPS): SPS is a national association of undergraduates interested in sharing their physics experiences. Wesleyan's SPS chapter meets to support each other in the scientific community, plan department activities, and pursue community outreach. The chapter mentor is Professor George Paily (gpaily@wesleyan.edu).

BA/MA PROGRAM

This is a curricular option for those students who, along with their research mentor, desire an intensive research experience that an additional year of study can afford. During the additional year, the student will complete additional

coursework and write an MA thesis based on original research. Interested students should consult their research mentor as early as possible.

HONORS

Honors candidates in Physics must submit a thesis describing the investigation of a project carried out by the candidate under the direction of a member of the Physics department. The candidate must also have attained a minimum average of B (85.0) for honors and B+ (88.3) for high honors in the eight lecture courses applied to the major (except those taken in the final semester of the senior year). Honors status is recommended by the faculty thesis readers and confirmed by the department.

CAPSTONE EXPERIENCE

The Physics department offers the following capstone experiences:

Two-semester senior thesis Seminar in atomic and molecular physics (PHYS507/PHYS508) Seminar in condensed matter physics (PHYS505/PHYS506) Seminar in theoretical physics (PHYS509/PHYS510)

Physics Colloquium (PHYS521/PHYS522)