

University of Notre Dame

THE PHYSICS MAJOR

Bachelor of Science with a Major in Physics

Science undergraduates may choose from two majors within the Department of Physics: **Physics** and **Physics in Medicine**. The course sequences in these two programs are designed to accommodate the academic and professional interests of the majority of physics majors.

The basic physics major is a particularly flexible option for students, and is the one that will be chosen by the majority of undergraduates majoring in the department. Students following the physics major program will gain a basic broad understanding of the concepts of physics. Depth is gained through the optional addition of one or more **concentration programs** offered through the department. Two of these concentration programs, **Advanced Physics** and **Astrophysics**, help to prepare the student for graduate work in physics, astronomy, or astrophysics. The **Applied Physics** concentration allows the student to combine the physics major with a sequence of courses in a particular engineering discipline. Completion of these concentrations is indicated on the student's final transcript.

Students with interests in other areas have time to explore second major, minor, or concentration options offered through departments in the Colleges of Science or Arts & Letters. Students with interests in alternative advanced Physics courses should discuss these with the Director of Undergraduate Studies.

While no supplemental concentration is *required* of **Physics** majors, interested students are allowed and encouraged to add as many concentrations as their schedules and interests allow. Students following the **Physics in Medicine** major are *not* allowed to add concentrations; the major program is already designed to accommodate the special interests of those students intending careers in medicine.

Physics as a Second Major is an option for students in the Colleges of Engineering, Arts & Letters, or Business.



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DEGREE REQUIREMENTS

First Year	Fall Semester	Spring Semester
	Physics A Lecture & Lab PHYS 10411/11411 4 credits	Physics B Lecture & Lab PHYS 10422/11422 4 credits
<i>First year students must meet the College of Science requirements.</i>		
Sophomore	Physics C PHYS 20433 3 credits	Physics D Modern Physics PHYS 20444 3 credits
	Intro to Circuitry & Electronics PHYS 20430 1.5 credits	Intermediate Mechanics PHYS 20454 3 credits
	*Math Methods in Phys I & Tutorial PHYS 20451/22451 3.5 credits	**Math Methods in Phys II & Tutorial PHYS 20452/22452 3.5 credits
	Sophomore Seminar PHYS 23411 1 credit	
Junior	Thermal Physics PHYS 30461 3 credits	<i>The spring semester of the Junior year is the preferred time for a semester abroad or for taking Literature and Fine Arts electives.</i>
	Electricity & Magnetism PHYS 30471 3 credits	<i>See Concentrations and Electives for elective courses taught in spring.</i>
	Quantum Mechanics I PHYS 40453 3 credits	
Senior	*** Modern Physics Electives PHYS 50501 Fall 3 credits	*** Modern Physics Electives PHYS 50602 or PHYS 50701 Spring 3 credits
	Modern Phys I Lab PHYS 41441 3 credits	Modern Phys II Lab PHYS 41442 3 credits

Fall or Spring may differ from year to year.

Please be aware the order the classes are taken differ between Math and Physics.
Check with the Director of Undergraduate Studies.

*Math 20750, 30750 may substitute.

**Math 20580, 20610 may substitute.

*** One of these courses, minimum, must be taken (Fall or Spring). See *Commonly Offered Physics Electives*.

Science Requirements

In addition to the Physics courses listed here, majors are expected to complete the standard university requirements, as well as two semesters of Chemistry and three semesters of Calculus for students in science and engineering.

Not all science courses will count toward degree credit or science elective credit for science majors. The survey science courses offered as options for non-science majors for their University science requirement will not count as a science elective or toward the minimum science credit hour requirement.

All College of Science courses offered by a major program must be taken at the University of Notre Dame. If a student wants to take a course outside Notre Dame for credit toward the Notre Dame degree, prior approval of the dean's office must be obtained. This does not apply to the courses taken by a transfer student prior to attending Notre Dame.

Language Requirements

The College of Science requires language proficiency through intermediate level in one of the following languages: Arabic, Chinese, French, German, Greek, Irish, Italian, Japanese, Korean, Latin, Portuguese, Russian or Spanish. Students may complete the language requirement by either completing a course taught at intermediate level or by demonstrating proficiency through placement examination.

CONCENTRATIONS & ELECTIVES

Advanced Physics Concentration

- Junior Seminar, PHYS 33411 (1 credit, Fall)
- Senior Seminar, PHYS 43411 (1 credit, Fall)
- Electromagnetic Waves, PHYS 30472 (Spring)
- Mod Phys Lab II, PHYS 41422 (Spring) or a 40000 level Math or ACMS class
- Quantum Mechanics II, PHYS 40454 (Spring)

Astrophysics Concentration

- Junior Seminar, PHYS 33411 (1 credit, Fall)
- Senior Seminar, PHYS 43411 (1 credit, Fall)
- Intro Astronomy & Astrophysics, PHYS 20481 (Fall)
- Mod Observational Techniques, PHYS 50481 (Fall)
- Relativity: Special & General, PHYS 50472 (Spring)
- Advanced Astrophysics, PHYS 50201 (Fall)

Applied Physics Concentration

Students complete at least 15 credits hours of courses in the College of Engineering, chosen with the aid of the Director of Undergraduate Studies. As shown in the examples below, the student is expected to complete a five-course sequence with two of the courses at the 20000 level and remaining three courses (9 credits) at the 30000/40000 level. At least six of these nine credit hours must be engineering credits. Three of the credit hours may come from a 30000/40000 level physics course appropriate in the selected course of study. Specific curricula can be generated to meet the student's particular interests.

Aeronautics

16 Credits

- Mechanics I, AME 20221 (Fall)
- Thermodynamics, AME 20231 (Spring)
- Fluid Mechanics, AME 30331 (Fall)
- Theory/Experimental Aerodynamics, AME 30333 (Spring)
- Gas Turbines & Propulsion, AME 40431 (Fall)

Computer Engineering

16 Credits

- Fundamentals of Computing I, CSE 20211 (Fall)
- Fundamentals of Computing II, CSE 20212 (Spring)
- Data Structures, CSE 30331 (Fall)
- Database Concepts, CSE 30246 (Fall)
- Computer Engineering Elective, 30000 or 40000 level

Commonly Offered Physics Electives

- | | |
|--------------|-------------------------------------|
| • PHYS 20420 | Computational Methods in Physics |
| • PHYS 20481 | Intro to Astronomy and Astrophysics |
| • PHYS 30389 | Philosophical Issues in Physics |
| • PHYS 30432 | Lasers and Modern Optics |
| • PHYS 48480 | Undergraduate Research |
| • PHYS 50201 | Physics of Astrophysics |
| • PHYS 50472 | Relativity: Special and General |
| • PHYS 50501 | Intro to Solid State |
| • PHYS 50481 | Modern Observational Techniques |
| • PHYS 50602 | Particles and Cosmology |

Honors Track in Physics

The goal of this honors track is to give our most talented students an exceptional background in Physics research, preparing them for successful postgraduate work.

Students who have identified their research advisor in the Physics Department and have already completed one semester of undergraduate research can apply in the Spring of their Sophomore year. Acceptance will be based on a research statement and transcript. At acceptance into the program a formal agreement will be set up between the student and the advisor.

PHYSICS IN MEDICINE

Fall Semester	Spring Semester
General Physics A Lecture & Lab PHYS 10411/11411 4 credits	General Physics B Lecture & Lab PHYS 10422/11422 4 credits

General Physics C PHYS 20433 3 credits	Math Methods in Phys II & Tutorial PHYS 20452/22452 3.5 credits
Intro to Circuitry & Electronics PHYS 20430 1.5 credits	Intermediate Mechanics PHYS 20454 3 credits
Math Methods in Phys I & Tutorial PHYS 20451/22451 3.5 credits	Modern Physics I PHYS 20464 3 credits
Sophomore Seminar PHYS 23411 1 credit	

Quantum Mechanics I PHYS 40453 3 credits	<i>The spring semester of the Junior year is the preferred time for a semester abroad or for taking Literature and Fine Arts electives.</i>
Electricity & Magnetism PHYS 30471 3 credits	

Other Science Courses	Course Titles	Credits	Semester Offered
BIOS 20201/21201	General Biology A Lecture & Lab	4	Fall
BIOS 20202/21202	General Biology B Lecture & Lab	4	Spring
CHEM 10171/11171	Intro to Chemical Principles Lecture & Lab	4	Fall
CHEM 10172/11172	Organic Struct & Mechanisms Lecture & Lab	4	Spring
CHEM 20273/21273	Organic Reactions & Apps Lecture & Lab	4	Fall
CHEM 20274/21274	Advanced General Chemistry Lecture & Lab	4	Spring
MATH 10550	Calculus I & Tutorial	4	Both
MATH 10560	Calculus II & Tutorial	4	Both
MATH 20550	Calculus III & Tutorial	3.5	Both

Additionally, PHIM majors must complete 9 credits of science electives to be chosen from the following list:

- PHYS 40371 Medical Physics (As offered)
- PHYS 50401 Physics of Cells (Fall)
- BIOS 20303 Fundamentals of Genetics (Spring)
- BIOS 30344 Vertebrate Physiology (Fall & Spring)
- BIOS 30341 Cellular Biology (Fall & Spring)
- CHEM 40420 Principles of Biochemistry (Fall & Spring)

PHYSICS FAQ

What curriculum options exist for a physics major?

We offer a basic physics major with 60 credits of science, of which 42 are in physics. This can be supplemented with concentrations of 14 credits each in advanced physics, astrophysics, and/or computing. There is a separate physics-in-medicine major designed for pre-meds or students with an interest in medical technology.

Is there a foreign language requirement?

All College of Science major programs require competency in one foreign language at the Intermediate I level.

How many students are in the physics major?

We have about 30 majors in each year. Roughly 12 are pre-Medical, 2-3 are pre-law, 2-3 are pre-business, with the remainder interested in pursuing physics, astronomy, math, or engineering careers.

Who will teach my courses?

At Notre Dame you will be taught by faculty who have been recruited from around the world, chosen for their outstanding research programs and their commitment to teaching. The professors are approachable, welcome student interaction, and bring their research into the classroom.

Can I take courses outside the major?

Yes! Unlike some fields, our degree program has plenty of flexibility for coursework outside physics. Most of our majors find a “second love” and take a minor or second major in that field. A surprising number of physics majors are musicians and take lessons or join performance groups. We support the Notre Dame commitment to educating the whole student—you will receive a true liberal education, not just job training.

Can I double major?

Yes! Roughly one-third of our majors have a second major. The most common is math, but successful options have included anthropology, philosophy, theology, computer science, foreign languages, and others.

Can I go abroad?

Yes! The major is designed so that the spring of junior year can be taken abroad, and about half of the physics majors take advantage of that time to go to London, Rome, Dublin, Chile, Toledo, or other points. It is harder for physics pre-meds to go abroad, but it can be done with careful planning.

Do I take physics courses abroad?

It depends. Students going to University College (Dublin) for a semester, or to Trinity, Oxford, or Cambridge Universities for a year will take math and physics courses while abroad. Students at other sites usually do not, unless we web broadcast a Notre Dame course (which we often do).

Can I do research during the semester?

Yes! The majority of our majors do research in our department or in allied departments. Research opportunities for pay or credit abound, and we encourage our majors to get into research as early as freshman year.

Can I do research during the summer?

Yes! By the end of sophomore year, most majors have lined up summer research positions, either at Notre Dame or elsewhere. Notre Dame is one of the oldest and largest participants in the National Science Foundation’s Research Experience for Undergraduates (REU) Program. Students can live in dorms at no cost while getting paid to do research. Or you can pick an institution close to home or in some exotic locale to spend your summer doing research. We even send students to Europe for their summer research.

Is there a senior thesis?

Not a required one, unless you are in the Honors Program. However you may write one if you like and we are working on creating an “honors” version of the Physics degree for those that do a thesis.

Can I have a social life?

Like all science majors, physics students do have a strenuous workload, especially in the sophomore and junior years, but the camaraderie among the majors is high and most find ample time to play sports, join musical groups, or pursue outside interests. The faculty and majors also like to get together for dinner parties, barbeques, and pool tournaments, or just to hang out in the physics majors’ study lounge. Come join us!

How can I get more information?

Visit the Department of Physics office:
225 Nieuwland Science Hall
(574) 631-6386 <http://physics.nd.edu>

WHY PHYSICS?

What is physics?

The word “physics” comes from the Greek, meaning “knowledge of nature” and was once called “natural philosophy.” Physicists ask and answer the most fundamental questions in science, like “What is the universe made of?” or “What laws govern all of nature?” or “What are matter, space, and time?” Even seemingly philosophical questions like “What is the nature of reality?” can be approached using mathematics and experiment, the two primary tools of physics.

Physics is the science that underlies all other sciences and engineering. Its discoveries impact *every* corner of science, technology, and even the humanities.

Physics is a broad science, encompassing many sub-fields that study the universe at its largest (astronomy & astrophysics), its smallest (nuclear & particle physics), and points in between. It touches on the cores of every other science (biophysics, applied physics, medical physics). It is both an applied field that leads directly to technological innovation (solid state & atomic physics) and an abstract field devoted to questions which have puzzled mankind since ancient times (cosmology & theoretical physics).

Physicists are at the forefront in the creation of the modern world. Physicists discovered radio waves, x-rays, radioactivity, electromagnetism, superconductivity, and the structure of the atom and its constituents. They invented radar, transistors, computers, lasers, MRI's, electron microscopes, nuclear power, and the CCD at the heart of your digital camera. Even the World Wide Web was born from a physics research program.

Physicists explained gravity, discovered how the sun works, found planets beyond our own, and measured the distances and ages of the stars and of the universe itself. And physicists have brought us some of the greatest advances in the realm of human intellect: the Laws of Mechanics and Electromagnetism, the Theory of Relativity, Quantum Mechanics, and the Big Bang Model. The pantheon of physics includes quite a few giants: Galileo, Newton, Maxwell, Einstein, Feynman, and Hawking among many others.

What can I do with a physics degree?

Almost anything!

A physics degree is not just an education in physics, it is an education in problem solving and mathematical modeling.

Nationally, 55% of physics majors continue on to graduate degrees, usually in physics, engineering, medicine, law, math, or another science. A physics degree is sought after by law, medical, and business schools because it represents completion of an intense training in how to think critically. And this training is easy to notice. When physics majors take graduate school entrance exams they usually come out on top.

Physics majors:

- Earn the highest score on the GRE graduate school entrance exam of any and all college majors. They rank at the top of the Quantitative and the Analytical Thinking sections and score higher on the Verbal section than all other science, engineering, and business majors.
- Earn the highest scores on the LSAT law school entrance exam of any and all other college majors.
- Earn the highest scores on the GMAT business school entrance exams of all majors, including business majors.
- Earn the second highest scores on the MCAT medical school entrance exams, after biomedical engineers, but ahead of biology majors.

The 45% that don't continue their education find a variety of positions, usually in the fields of computer science, engineering, management, finance, and education. Business consulting and international finance firms recruit physics majors enthusiastically for their analytic training. So even if a physics major never solves the Schrödinger Equation again, their degree is the mark of a deep and broad preparation for life in our modern world.

