

# Physics

## Curriculum

The physics curriculum is designed with considerable flexibility in order to accommodate the variety of interests, plans, and needs of majors. At the same time, it provides a broad and thorough understanding of the fundamental ideas and concepts related to the physical world surrounding us. Using this broad base, which stresses fundamentals, undergraduates may enter graduate work in one of the pure or applied sciences or one of the non-sciences such as education, business administration, law, journalism, or philosophy. They may also choose to go directly into jobs in education, industry, government, or business.

The Department of Physics offers several undergraduate degree options, as well as Master of Science and Doctor of Philosophy degrees. The faculty in all research groups are strongly committed to enriching the undergraduate experience by providing opportunities for undergraduates to fully participate in cutting-edge research projects working alongside faculty and graduate students.

An overview of the physics department can be found at [physics.montana.edu](http://physics.montana.edu)

## Professional Option

Intended primarily as preparation for graduate work in one of the physical sciences or for those who desire a career in the physical sciences, the professional option provides a sound background in the fundamentals of physics and mathematics.

## Interdisciplinary Option

This option requires a minimum of 16 credits in the declared area and is designed for those students who desire a firm background in mathematics and physics coupled with a concentration in another discipline. Example declared areas are chemistry, biology, computer science, engineering, environmental studies, pre-law, pre-med, business, marketing, material science, optics, or technical writing. Each student will work out a specific coordinated program with their physics advisor and an advisor in the declared area. The 16 credits of coursework in the declared area must be 100 level or higher and approved by the student's physics advisor. Courses at the 100 level will be approved as needed to allow the student to obtain the appropriate prerequisites for 200 and higher level courses in the declared area.

## Teaching Option

This option is intended primarily as preparation for secondary school teachers. Teaching options require a teaching minor from the list under the Department of Education. However, the only teaching minor that can be completed within 128 credits is Mathematics. Please contact the department advisor for specifics on other options.

## Physics Minor (Non-teaching)

The physics minor is designed to provide students with a fundamental background in physics and mathematics, strengthening analytic and problem solving skills, which can be applied to multiple disciplines.

## Optics Minor (Non-teaching)

The undergraduate non-teaching minor in optics provides a core set of knowledge and skills necessary to participate in the rapidly growing opportunities in optical science and engineering. Requirements include courses in optics, electrical engineering and physics, as well as electives chosen to match the interests and needs of each student.

Students pursuing the BS in Physics Professional Option or the BS in Physics Interdisciplinary Option can earn the Optics Minor with no extra credits by carefully selecting physics electives, by taking EELE 482 as one of their university or declared area electives, and by completing optics-related research (PHSX 490R and PHSX 499R) as their required senior project.

## Materials Minor (Non-teaching)

Montana State University, Bozeman, offers a non-teaching minor in Materials Science & Engineering called the Minor in Materials. This minor provides courses from a variety of disciplines which are relevant to synergies of science and engineering in polymer, metallic, ceramic, hybrid, and composite materials for both structural and functional application. The minor requires a minimum of 32 credits comprised of 14 credits of required coursework (or equivalent) followed by 18 credits of elective coursework.

## Research Opportunities

Research programs in the Department of Physics are currently focused in several areas: optical science and laser technology, condensed matter physics, gravitational physics, astrophysics, solar physics, and science education. The MSU Gravity Group studies extreme astrophysical phenomena, such as the inspiral and merger of black holes and neutron stars, to further our understanding of astrophysics and fundamental physics. Our programs in astrophysics and relativity are directed toward a fundamental understanding of the behavior of matter and energy on the astrophysical scale. Our solar physics group studies phenomena such as solar flares and prominences associated with the star nearest us, the sun. Our research in the physics of lasers and condensed matter systems - such as magnetic and dielectric materials, semiconductor and metal surfaces and thin films, microwave photonic devices, laser materials and superconducting solids - enlarges the knowledge base on which future advances in technology are founded. Our research in science education aims to improve the understanding of how students can best learn science in the schools, colleges, and universities. All of the Department's research activities enhance our instructional programs by involving undergraduate students in capstone research problems and techniques at the frontiers of physical knowledge. Faculty working with the most advanced techniques on current topics carry their research experience into the classrooms at all levels.

Our research groups foster interactions among the faculty, undergraduate and graduate students, research scientists, visiting scientists, and other departments and centers. Our research facilities at the Engineering and Physical Science (EPS) Building include state-of-the-art laboratories and equipment. External collaborations bring national and international experts to the department and open opportunities for research to be conducted at other world-class laboratories around the globe. On-campus, interdisciplinary research include collaborations with the departments of Chemistry and Biochemistry, Electrical and Computer Engineering, Mechanical Engineering, and several research centers and institutes on campus including the Space Science and Engineering Laboratory (SSEL), the Imaging and Chemical Analysis Laboratory (ICAL), Montana Space Grant Consortium (MSGC), the Optical Technology Center (OpTeC), and the Spectrum Lab and interdisciplinary academic programs, such as Material Science and Optics and Photonics undergraduate and graduate degree programs. Research collaborations with local industries are numerous and actively pursued. For more information on each research program, click here (<http://www.physics.montana.edu/research/resgroups.htm>).

## Undergraduate Research Participation

An integral component of all undergraduate major programs in physics is participation in undergraduate research. Based on student interest,

the faculty work closely with students in identifying and addressing important problems in particular sub-fields. Completion of a minimum of 2 credits of undergraduate research/creative activity (PHSX 490R) is required prior to taking the capstone course PHSX 499R. Some students extend this experience beyond the minimum and work in research labs throughout their undergraduate program, including summers. Students from other majors who demonstrate interest and ability are also welcome to participate in undergraduate research in physics.

### Senior Project

Students in the professional and interdisciplinary options will complete senior projects that integrate their physics knowledge and problem solving skills with research/creative activities. The senior project is designed to give a student the opportunity to develop skills that are necessary for work in a professional scientific environment by integrating their physics knowledge and problem solving skills with research/creative activities. For this activity, the student must enroll in a minimum of 2 credits of undergraduate research/creative activity (PHSX 490R). The results of this senior project are generally the basis for the presentation given in the capstone course PHSX 499R.

The senior project will be based on a collaboration of a student with a mentor on a project that is of interest to the student, is either experimental or theoretical in nature, has a defined objective, and is primarily based on the student's own work. Usually these senior projects are based on research guided by one of the faculty in the Physics Department; however, there are several other options available to the student for these senior projects. Other options include, but are not limited to, research projects done by the student in other departments at Montana State University, research projects done by the student at other institutions which may occur during a student exchange program or on a summer intern program, and independent research/creative activity done by the student under the guidance of the student's faculty advisor.

### Capstone Experience

Students in the professional and interdisciplinary options will present the results of their senior project in oral and written forms in the capstone course PHSX 499R.

The capstone experience for those in the Physics Teaching Option is EDU 495 - Student Teaching. Each student will submit a written report from the supervising teacher and a written self-assessment.

### Departmental Honors in Physics

When appropriate, majors should consider the opportunities afforded by the departmental honors program. This program has the following requirements:

1. A minimum 3.5 grade-point average (GPA) in physics; 3.0 GPA overall.
2. A minimum of four credits of undergraduate research credit.
3. An acceptable, bound senior thesis, and an oral defense of the thesis.
4. Participation in a physics seminar for one semester in either the junior or senior year.

A detailed description of the program is available from the department.

### Undergraduate and Graduates Courses

- Physics (PHSX) Courses (<http://catalog.montana.edu/coursedescriptions/phsx>)
- Physics-Astronomy (ASTR) Courses (<http://catalog.montana.edu/coursedescriptions/astr>)

### Undergraduate Programs

- Professional Option (<http://catalog.montana.edu/undergraduate/letters-science/physics/professional-option>)
- Interdisciplinary Option (<http://catalog.montana.edu/undergraduate/letters-science/physics/interdisciplinary-option>)
- Physics Teaching Option (<http://catalog.montana.edu/undergraduate/letters-science/physics/physics-teaching-option>)

### Undergraduate Minor

- Physics Minor (Non-Teaching) (<http://catalog.montana.edu/undergraduate/letters-science/physics/physics-minor-nonteaching>)
- Optics Minor (Non-Teaching) (<http://catalog.montana.edu/undergraduate/engineering/electrical-computer-engineering/electrical-engineering/optics-minor-nonteaching>)
- Materials Minor (Non-Teaching) (<http://catalog.montana.edu/undergraduate/engineering/mechanical-industrial-engineering/materials-minor>)

### Graduate Programs

The Physics Department offers a Master of Science (M.S.) degree in physics and a Doctor of Philosophy (Ph.D.) degree in physics.

The Physics, Electrical Engineering, and Chemistry Departments offer a Master's Degree in Optics and Photonics.

Information concerning the physics graduate program can be found at Physics Graduate Programs (<http://catalog.montana.edu/graduate/letters-science/physics>)

### **Font Notice**

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Adobe Garamond Pro.

The editor may contact Leepfrog for a draft with the correct fonts in place.