

Physics, Additional Major

Additional Major or Dual Degree in Physics

Physics may be taken as an additional major (also known as a “double major”) or as a second degree, with another department granting the primary degree. The rules of the Physics Department for these two options are distinct, as discussed below. Students interested in either option should contact Dr. Gillian Ryan, Director of Undergraduate Affairs, for assistance.

Applicants must have should have successfully completed at least one core physics course at Carnegie Mellon prior to applying for these options and must apply for the additional major no later than the add date of their final semester.

Additional Major

To receive an Additional Major in Physics, with another department granting the primary degree, all requirements of the B.S. in Physics (<http://coursecatalog.web.cmu.edu/schools-colleges/melloncollegeofscience/departmentofphysics/physics-bs/>) degree and the particular physics track (<http://coursecatalog.web.cmu.edu/schools-colleges/melloncollegeofscience/departmentofphysics/physics-bs/#tracktextcontainer>) (if desired) must be fulfilled except:

- No STEM Electives are required (beyond track requirements)
- No Non-Technical Electives are required
- 03-121 Modern Biology is not required
- 09-105 Introduction to Modern Chemistry I is not required
- No Free Electives are required

The full requirements are described below:

Physics Core:

All physics majors take these courses in physics, which are designed to teach the fundamentals required for any specialty. Most students take the 100-level courses in their first year of study, the 200-level courses in their second year, and the 300-level courses in their third or fourth year.

	Units
33-121 Physics I for Science Students	12
or 33-141 Physics I for Engineering Students	
or 33-151 Matter and Interactions I	
33-142 Physics II for Engineering and Physics Students	12
or 33-152 Matter and Interactions II	
33-104 Experimental Physics	9
33-201 Physics Sophomore Colloquium I	2
33-211 Physics III: Modern Essentials	10
33-231 Physical Analysis	10
33-202 Physics Sophomore Colloquium II	2
33-228 Electronics I	10
33-232 Mathematical Methods of Physics	10
33-234 Quantum Physics	10
33-301 Physics Upperclass Colloquium I	1
33-331 Physical Mechanics I	10
33-338 Intermediate Electricity and Magnetism I	10
33-341 Thermal & Statistical Physics	10
33-302 Physics Upperclass Colloquium II	1
33-340 Modern Physics Laboratory	10
Total Physics Core Units	129

Mathematics Core:

All physics majors take these calculus courses from the Department of Mathematics to support their studies in physics.

	Units
21-120 Differential and Integral Calculus	10
21-122 Integration and Approximation	10
21-259 Calculus in Three Dimensions	10
Total Mathematics Core Units	30

Technical Core for an Additional Major:

Students pursuing an additional major in physics do not need to fulfill the full Technical Core required by the Mellon College of Science, but are still required to take either 15-110 or 15-112 or 02-120 (or an equivalent course as pre-approved by the Director of Undergraduate Affairs).

	Units
15-110 Principles of Computing	10-12
or 15-112 Fundamentals of Programming and Computer Science	
or 02-120 Programming for Scientists	
Total Technical Core Units	10-12

Technical Electives for an Additional Major:

Students pursuing an additional major in physics must take the Physics Electives (p.) and Mathematics Elective required of physics as the primary major, but do not need to take the STEM electives. Students may choose these electives individually, but may opt to complete the requirements as part of the Physics Tracks (<http://coursecatalog.web.cmu.edu/schools-colleges/melloncollegeofscience/departmentofphysics/physics-bs/#tracktextcontainer>) described in the B.S. in Physics section. Students interested in completing an additional major with a track should consult with the Director of Undergraduate Affairs.

	Units
33-xxx Physics Breadth Elective	9-12
33-xxx 3 Qualifying Physics Electives	27-37
21-2xx Mathematics Elective	9-10
Total Technical Electives	45-59

Dual Degree

To receive a Dual Degree in another subject and Physics, **all requirements** of the Physics degree must be fulfilled, including the Mellon College of Science General Education requirements. Students may choose to complete the B.A. or the B.S. in Physics, with or without a track. Students must complete both the technical and non-technical requirements, and should consult with the Director of Undergraduate Affairs for questions about double counting. The number of total units required to earn a Dual Degree is 90 more than the total units required by the department requiring the fewer total units. Since Physics requires 360 units, the lowest possible minimum for a Dual Degree with Physics is 450 units.

Physics Electives

Physics Breadth Electives

Students pursuing a B.S. in Physics must take at least one course from the Physics Breadth Elective list to gain experience in a subfield of physics. Some tracks have this course prescribed, while others allow free choice from this list. All of these courses may also be taken as Qualifying Physics Electives, but they may not fulfill both requirements simultaneously.

	Units
33-224 Stars, Galaxies and the Universe	9
33-226 Physics of Energy	9
33-353 Intermediate Optics	12
33-355 Nanoscience and Nanotechnology	9
33-431 Stars and Black Holes	9
33-432 Galaxies	9
33-433 Cosmology	9
33-441 Introduction to Biophysics	10
33-444 Introduction to Nuclear and Particle Physics	9
33-448 Introduction to Solid State Physics	9
33-650 General Relativity	9

Total Physics Breadth Elective Units 9-12

Qualifying Physics Electives

Students pursuing a B.S. in Physics must take at least three courses totaling at least 27 units from the Qualifying Physics Elective list, not including the 100-level courses. Some tracks have these courses prescribed, while others allow free choice from this list, enabling students to choose between broad and in-depth study.

Students pursuing a B.A. in Physics must take at least two courses totaling at least 18 units from this list and may take **only one** of the 100-level courses.

Students pursuing a Minor in Physics must take at least three courses totaling at least 27 units from this list or non-prescribed courses from the Physics Core list.

While all courses on the Physics Breadth Elective list are also on the Qualifying Physics Elective list, a course may not fulfill both requirements simultaneously. Certain courses are offered only in alternate years, as indicated.

33-114	Physics of Musical Sound (B.A. and Minor only) ^a	9
33-115	Physics for Future Presidents (B.A. and Minor only) ^a	9
33-120	Science and Science Fiction (B.A. and Minor only) ^a	9
33-224	Stars, Galaxies and the Universe	9
33-226	Physics of Energy	9
33-241	Introduction to Computational Physics	9
33-332	Physical Mechanics II	10
33-339	Intermediate Electricity and Magnetism II	10
33-342	Advanced Thermal & Statistical Physics	10
33-350	Undergraduate Research ^b	Var.
33-353	Intermediate Optics	12
33-355	Nanoscience and Nanotechnology	9
33-431	Stars and Black Holes	9
33-432	Galaxies	9
33-433	Cosmology	9
33-441	Introduction to Biophysics	10
33-444	Introduction to Nuclear and Particle Physics	9
33-445	Advanced Quantum Physics I	9
33-446	Advanced Quantum Physics II	9
33-448	Introduction to Solid State Physics	9
33-451	Senior Research ^b	Var.
33-456	Advanced Computational Physics	9
33-499	Supervised Reading ^b	Var.
33-650	General Relativity	9
33-658	Quantum Computation and Quantum Information Theory	10
33-659	Modern Topics in Condensed Matter Physics	12
33-7xx	Physics Graduate Level Courses (see list below)	

Total Qualifying Physics Electives Units 27-37

a Only one of these three courses (33-114, 33-115, and 33-120) may be used for the B.A. These classes may not be used as Qualifying Physics Electives for the B.S.

b Only one of these three courses (33-350, 33-451, and 33-499) of 9 units may be used as a Qualifying Physics Elective. To be counted as a Qualifying Physics Elective, all 9 units must be taken in a single semester. Any exceptions must be approved by the Director of Undergraduate Affairs.

Qualifying Physics Electives Recommended for Physics Graduate School

Students planning to undertake graduate studies in physics are strongly advised to take the following courses, which may count as Qualifying Physics Electives and STEM Electives.

	Units
33-332 Physical Mechanics II	10
33-339 Intermediate Electricity and Magnetism II	10

33-445	Advanced Quantum Physics I	9
33-446	Advanced Quantum Physics II	9

Physics Graduate Courses

These courses are intended for graduate students in physics, but may be taken by advanced undergraduates as Qualifying Physics or STEM Electives. **Undergraduate students require special permission of both the course instructor and the Director of Undergraduate Affairs to register for these classes.**

	Units
33-731 Stars and Black Holes	12
33-732 Galaxies	12
33-733 Cosmology	12
33-755 Quantum Mechanics I	12
33-756 Quantum Mechanics II	12
33-757 Classical Mechanics	12
33-761 Classical Electrodynamics I	12
33-762 Classical Electrodynamics II	12
33-765 Statistical Mechanics	12
33-767 Biophysics: From Basic Concepts to Current Research	12
33-769 Quantum Mechanics III: Many Body and Relativistic Systems	12
33-770 Field Theory I	12
33-771 Field Theory II	12
33-779 Introduction to Nuclear and Particle Physics	12
33-780 Nuclear and Particle Physics II	12
33-783 Solid State Physics	12