CASE WESTERN RESERVE UNIVERSITY EST. 1826

PHYSICS

B.A. IN PHYSICS
B.S. IN PHYSICS
B.S. IN PHYSICS WITH MATHEMATICAL PHYSICS CONCENTRATION
B.S. IN PHYSICS WITH BIOPHYSICS CONCENTRATION
B.S. IN ENGINEERING, MAJOR IN ENGINEERING PHYSICS
B.S. IN MATHEMATICS AND PHYSICS
TEACHER LICENSURE IN PHYSICAL SCIENCES (CHEMISTRY AND PHYSICS)

Students pursuing work in physics master the techniques needed to understand the basic laws of nature and the properties of energy and matter in their various forms. The undergraduate curriculum in the Department of Physics reflects the needs of students and the varied interests of the faculty in the 21st century, and prepares students for a wide range of future activities. At the undergraduate level, students may choose from several different programs tailored to suit almost any set of interests and career plans. Electives within and outside of the department are available in the undergraduate program to provide the breadth and flexibility that will considerably enhance the student's opportunities at the best graduate schools and in industrial and government organizations.

DEPARTMENT HIGHLIGHTS

- In recent years, the department has introduced a number of new interdisciplinary programs aimed at specific student interests, including those in engineering physics, mathematics and physics, and biophysics.
- Two faculty members have won the Nobel Prize in physics, including the first U.S. Nobel Prize in Science, awarded to Albert A. Michelson in 1907. Members of the current faculty have received major awards from the American Physical Society, the American Institute of Physics, the American Association for the Advancement of Science, the National Science Foundation and the Guggenheim and Sloan Foundations. Over a dozen current faculty members are Fellows of the American Physical Society.
- The department values excellence in teaching in coordination with research. Physics faculty members are regularly nominated for the Wittke Award, the university's highest undergraduate teaching award.
- Each major completes a SAGES Capstone Project in the senior year, which involves a full year of research working directly with a faculty member. Recent senior projects include: Holding Atoms Still Using Beams of Light; A Nuclear Magnetic Resonance-based Desktop Imaging System; Modeling Baseball Trajectories; and Axions and Dark Energy in the Universe.
- Each year, physics majors are awarded prestigious fellowships including National Science Foundation Postgraduate Fellowships and Churchill Fellowships. Two of the department's former undergraduates have gone on to win the Nobel Prize in physics.
- The Physics and Astronomy Club is a chapter of the National Society of Physics Students. The club sponsors trips to physics labs around the country and welcomes outside speakers. The department also brings in world-renowned physicists; the Michelson Lecture Series has hosted six Nobel Laureates in the past six years. Stephen Hawking visited the department in the fall of 2003.
- The department also administers a B.S. in engineering with a major in engineering physics. The degree is granted by the Case School of Engineering.

DEGREE REQUIREMENTS AND COURSE OFFERINGS

The B.A. degree program includes a large number of elective courses, making it easy for the student to pursue other interests or complete a second major while earning a degree in physics. The B.S. degree has two alternatives to the standard program: a mathematical physics concentration and a biophysics concentration.

The B.S. in mathematics and physics degree is a single degree for students interested in both advanced mathematics and theoretical physics and their relationships. This degree is distinct from the mathematics physics concentration in the B.S. program.

Students may be advised by either physics or mathematics faculty members and will complete a significant number of advanced math courses and somewhat fewer experimental lab courses than in the B.S. in physics program.

All B.A. and B.S. candidates complete a year-long senior project in which the student works individually with a faculty researcher, writes a senior thesis and makes a presentation at a special senior project seminar.

The typical four-year programs for all degrees are illustrated in this brochure. Please see the General Bulletin (www.case.edu/bulletin) for detailed course descriptions.

Minor

A minor in physics appeals to students who have an interest in physics but intend to pursue a degree in some other field. If this other field is a technical discipline, it is likely that it already requires two or three of the courses needed for a physics minor. In this case, only two or three additional courses are necessary for completion of the minor. Required courses include PHYS 121 (or 115 or 123) and PHYS 122 (or 116 or 124) and PHYS 221. Students must also take two* of the following courses: PHYS 196, 204 (or 208), 309, 310, 313, 315, 316, 326, 331, 332, 324, 328 (or 336).

* Engineering students may have to choose between using physics courses as technical electives or counting them as part of a minor in physics.

SPECIAL ACADEMIC PROGRAMS

Teacher licensure in physical sciences

Two options are available within the B.A. in physics major for students to become eligible for licensure as teachers in secondary schools (adolescents to young adults) qualified to teach physics or physical sciences (both physics and chemistry). In addition to content requirements, a 35 credit hour sequence in professional education is required, comprised of courses taken at Case and John Carroll University; student teaching is part of the curriculum. Students interested in either option should contact Professor Gary Chottiner for further details.

B.S./M.S. in physics entrepreneurship

This master's degree program is designed to empower graduates to create high tech companies. Students in this program have gone on to win the Case's Weatherhead School of Management business launch competition, and graduates have launched new companies. Students may consider a five-year program in this area.

Cooperative education

The co-op program provides students the opportunity to engage in full-time, paid employment, consistent with their major fields of study. Typically, students participate for one to two seven-month periods, such as summer-fall and/or spring-summer, beginning after their sophomore or junior year. This is most common for students in engineering physics. Although participation in the program extends the time required to achieve a bachelor's degree, students often benefit from higher starting salaries and greater lifetime earnings that can result from the experience acquired in co-op assignments.

B.S.E. in Engineering Physics

The study of physics has been a driving force behind the development of new technology. In a high-tech world, a strong grasp of underlying physical principles and problem solving strategies is necessary to keep up with new developments. The engineering physics program offers an opportunity to develop this understanding through a rigorous physics program in an engineering context.

The engineering physics major is appropriate for preparing students to pursue careers in industry, either directly after undergraduate studies or following graduate school in engineering or physics. It is also excellent preparation for those interested in an academic career in engineering or applied physics. Many employers value the unique problem-solving approach of physics, particularly in industrial research and development.

The degree of Bachelor of Science in engineering, major in engineering physics is offered from the Case School of Engineering and confers an engineering credential. Students in this program are required to complete the engineering core Curriculum as well as a rigorous course of study in physics. Engineering concentration areas include:

Aerospace engineering
Biomedical engineering "hardware"
Biomedical engineering "software"
Chemical engineering
Civil engineering (solid mechanics, structural and geotechnical, environmental)
Computer science
Computer systems hardware
Computer systems software
Control systems and automation
Electrical engineering
Macromolecular science
Materials science and engineering
Mechanical engineering
Signal processing
Systems analysis
Decision making

FACILITIES AND RESEARCH

All physics teaching and research is carried out in the newly renovated facilities in the Rockefeller Building. This six million dollar renovation of teaching and research labs and lecture facilities produced a state-of the-art department featuring networked learning and videoconferencing. The department boasts laboratories for undergraduate experimental work that are among the best in the country. Experiments in the junior year are selected from a wide range of possibilities, with the general level of sophistication increasing as the student advances.

Most physics majors take a sequence of four laboratory courses that use research-quality equipment, computer software, and data analysis to prepare them to do independent research during the senior year. Experiments include: ultrahigh vacuum studies of electron interactions with surfaces, superconductivity, chaos, light scattering, nonlinear optics, magnetic resonance and Josephson Junctions.

The department maintains research laboratories in experimental and theoretical astrophysics and cosmology, elementary particle physics, low-temperature physics, optics, condensed matter physics, surface physics, medical physics and industrial physics. There are active collaborations underway with the Center for Particle Astrophysics at University of California at Berkeley and the NASA-Caltech Jet Propulsion Laboratory in Pasadena. Case leads a multi-university collaboration doing astrophysics at the South Pole Research Station. Researchers are also working with colleagues at the University of Chicago and McGill University on a major project at the National Solar Thermal Test Facility at Sandia National Laboratories in Albuquerque.

RECENT GRADUATES

The Department of Physics currently has between 20 and 30 majors in each class. Last year, 100 percent of graduates proceeded to graduate school, though not all for further study in physics. Recent bachelor's degree recipients have gone to Cal Tech, MIT, Harvard University, University of California at Berkeley, the University of Chicago, Princeton, Brown, Stanford, the Institute of Optics, Marseille University in France and the University of Munich in Germany, among others.

Other graduates have been employed in laboratories at IBM and Intel, and some have gone to professional schools in medicine and law. A number of physics graduates have started their own companies.

BACHELOR OF ARTS IN PHYSICS

The B.A. degree in physics is our most flexible degree program. It is possible under this program to take almost all of the courses needed for the physics B.S. but the actual requirements are reduced by 24 credits of physics courses and a science lab. This makes the B.A. degree particularly attractive to students who wish to combine a study of physics with the pursuit of other interests. Often such students complete a second major in the arts, humanities or social sciences. B.A. students are also frequently interested in following the B.A. with a professional degree in medicine, law or business. The empirical foundations of modern physics provide an interesting and coherent core for a diverse range of careers. The impact of science and technology on all areas of human activity is growing steadily. Understanding the realities of the scientific enterprise can be essential in business, finance, medicine, law, the media, literature, the arts, general education, government and any number of other pursuits.

The 36 credits of required physics courses provide exposure to a broad range of physical phenomena as well as training in the scientific method, techniques of problem solving, data analysis, quantitative approaches to physical problems and experimental methods. Although less intense than the B.S. program, the B.A. program can still provide an excellent preparation for graduate study in physics, comparable to undergraduate programs in physics at some of the best liberal art universities. At the same time, reduced requirements for technical courses in the physics B.A. program provide an opportunity to explore other disciplines in depth. In the senior year, each student works on an independent, two-semester, experimental or theoretical research project leading to a paper, and a public presentation in the styles expected by the American Physical Society, the premier professional society of physicists.

Course	Year [1]	Cr.
PHYS 115, 121 or 123 Physics I Mechanics	1	4
PHYS 116, 122 or 124 Physics II Electricity & Magnetism	1	4
PHYS 221 Introduction to Modern Physics.	2	3
PHYS 250 Mathematics, Physics and Computing	2S	3
PHYS 203A Electronics Laboratory (B.A.) [2]	3F	2
PHYS 301B Advanced Laboratory Physics (B.A.) [2]	3F	2
PHYS 313 Thermodynamics & Statistical Mechanics	3F	3
PHYS 331 Introduction to Quantum Mechanics I	3F	3
PHYS 351 Physics Senior Project (Senior Capstone) [3]	4	4
PHYS 352 Senior Project Seminar	4	2
Two of the following:		
PHYS 310 Classical Mechanics	2S	3
PHYS 324 Electricity and Magnetism I	3S	3
PHYS 315 Introduction to Solid State Physics	4F	3
PHYS 316 Intro. to Nuclear & Particle Physics	4S	3
PHYS 326 Physical Optics	S	3
PHYS 328 Cosmology and Structure of the Universe [3] *or* PHYS 336 Modern Cosmology [3]		3
PHYS 365 General Relativity	F	3
Intro. Science 1 [4]	1	3 (4)
Intro. Science 2 [4]	1	3 (4)
ENGR 131 Elementary Computer Programming [5]	1	3
MATH 121, 123 or 125 Calculus I	1	4
MATH 122, 124 or 126 Calculus II	1	4
MATH 223 or 227 Calculus III	2	3
MATH 224 Differential Equasions	2	3
SAGES First/University Seminar	1, 2	10
PHED Physical Education Activities (two semesters)		0
Breadth requirements [6]		12
Open electives [7]		42
Total		**120**

1. "Year" indicates the year in which the course usually taken; F or S indicates that a course is offered only in the fall or spring, respectively.
2. PHYS 203A and 301B together will likely fulfill the SAGES Departmental Seminar requirement.
3. Students may choose only one of these two cosmology courses to satisfy the requirements of the B.A. degree.
4. A two-course science sequence chosen from: CHEM 105 and 106; CHEM 111 and ENGR 145; or BIOL 214 and BIOL 215; or another two-course sequence totaling six or more credits in a quantitative science (other than physics), with written approval of the Physics Undergraduate Curriculum Committee.
5. Another computational course may be taken with approval.
6. The breadth requirements include six hours of Social Sciences and six hours of Arts and Humanities. This may increase by three credits if the required Global and Cultural Diversity course is not also one of the breadth requirement courses. Courses required for the B.S. in Physics satisfy the six credit GER for Natural and Mathematical Sciences as well as the Quantitative Reasoning course requirement
7. The B.A. degree requires a minimum of 30 semester hours at the 300-400 level, of which only 22 are specified as PHYS courses.

BACHELOR OF SCIENCE IN PHYSICS

The B.S. degree in physics is traditionally taken by students interested in a career in physics research in government or industry, or in college- and university-level teaching and research. Nationally, about half of all B.S. physics students go on to graduate school, either in physics, engineering, or another professional area. The others choose to take immediate employment in a variety of technical fields in industry and government. Case physics majors have been remarkably successful at winning prestigious National Science Foundation graduate fellowships and at being admitted to the best research universities, medical and other professional schools.

Each student works on an independent experimental or theoretical research project during the senior year leading to a paper and a public presentation in the styles expected by the American Physical Society, the premier professional society of physicists.

Course	Year [1]	Cr.
PHYS 121 or 123 Physics I Mechanics	1	4
PHYS 122 or 124 Physics II Electricity & Magnetism	1	4
PHYS 221 Introduction to Modern Physics.	2	3
PHYS 203 Analog and Digital Electronics	2F	4
PHYS 204 Advanced Instrumentation Laboratory	2S	4
PHYS 250 Mathematics, Physics and Computing	2S	3
PHYS 310 Classical Mechanics	2S	3
PHYS 301 Advanced Laboratory Physics I [2]	3F	4
PHYS 313 Thermodynamics & Stat. Mechanics.	3F	3
PHYS 331 Introduction to Quantum Mechanics I	3F	3
PHYS 302 Advanced Laboratory Physics II	3S	4
PHYS 324 Electricity and Magnetism I	3S	3
PHYS 332 Introduction to Quantum Mechanics II	3S	3
PHYS 325 Electricity and Magnetism II.	4F	3
PHYS 351 Senior Project (SAGES Capstone).	4	4
PHYS 352 Senior Project Seminar	4	2
Select one of the following three courses:		
PHYS 315 Introduction to Solid State Physics	4F	3
PHYS 326 Physical Optics	S	3
PHYS 327 Quantum Electronics	4F	3
Select one of the following four courses:		
PHYS 316 Intro. to Nuclear and Particle Physics	4S	3
PHYS 328 Cosmology & Structure of the Universe.	4	3
PHYS 336 Modern Cosmology	4	3
PHYS 365 General Relativity	4F	3

Course	Year [1]	Cr.
CHEM 105 or 111 Principles of Chemistry I.	1	3 (4)
CHEM 106 or ENGR 145 Principles of Chemistry II	1	3 (4)
CHEM 113 Principles of Chemistry Laboratory	1	2
ENGR 131 Elementary Computer Programming [3]	1	3
MATH 121 or 123 Calculus I	1	4
MATH 122 or 124 Calculus II	1	4
MATH 223 or 227 Calculus III	2	3
MATH 224 Elementary Differential Equations.	2	3
SAGES First/University Seminar	1, 2	10
PHED Physical Education Activities (two semesters)		0
Breadth requirements [4]		12
Open electives [5]		20
Total		**127**

1. "Year" indicates the year in which the course usually taken; F or S indicates that a course is offered only in the fall or spring, respectively.
2. PHYS 301 will likely fulfill the SAGES Departmental Seminar requirement.
3. Another computational course may be taken with approval.
4. The breadth requirements include six hours of Social Sciences and six hours of arts and humanities. This may increase by three credits if the required global and cultural diversity course is not also one of the breadth requirement courses. Courses required for the B.S. in physics satisfy the six credit GER for natural and mathematical sciences as well as the quantitative reasoning course requirement.
5. The number of open electives may vary as determined by the degree requirement that the total number of credits be at least 127.

BACHELOR OF SCIENCE IN PHYSICS, MATHEMATICAL PHYSICS CONCENTRATION

Students who are interested in theoretical physics and have a strong background in mathematics may apply for admission to a variation on the B.S. in physics, officially a B.S. in physics with a mathematical physics concentration. This program is based on the B.S. in physics, but with certain substitutions in the course requirements. Several of the laboratory courses are replaced by advanced mathematics courses and some of the undergraduate physics courses are replaced by graduate courses. **This program is not the same as the separate degree program, the B.S. in mathematics and physics, which is a coherent and parallel education in both mathematics and physics. See next page for details.**

Course	Year [1]	Cr.
PHYS 121 or 123 Physics I Mechanics	1	4
PHYS 122 or 124 Physics II Electricity & Magnetism	1	4
PHYS 221 Introduction to Modern Physics.	2S	3
PHYS 204 Advanced Instrumentation Lab	2S	4
PHYS 250 Mathematics, Physics and Computing	2S	3
PHYS 310 Classical Mechanics	2	3
PHYS 349 Methods of Mathematical Physics I	3F	3
PHYS 313 Thermodynamics & Stat. Mech.	3F	3
PHYS 481 Quantum Mechanics I	3F	3
PHYS 302 Advanced Laboratory II [2]	3S	4
PHYS 423 Classical Electromagnetism	4F	3
PHYS 482 Quantum Mechanics II	3S	3
Select one course from the following list:		
PHYS 315 Introduction to Solid State Physics	4F	3
PHYS 326 Physical Optics	S	3
PHYS 327 Quantum Electronics	4F	3
PHYS 350 Methods of Mathematical Physics II.	4F	3
PPHYS 351 Senior Project (SAGES Capstone)	4	4
PHYS 352 Senior Project Seminar	4	2
Select one course from the following list:		
PHYS 316 Intro. to Nuclear and Particle Physics	4S	3
PHYS 328 Cosmology & Structure of the Universe.	4	3
PHYS 336 Modern Cosmology	4	3
PHYS 365 General Relativity	4F	3
MATH 121 or 123 Calculus I	1	4
MATH 122 or 124 Calculus II	1	4
MATH 223 or 227 Calculus III	2F	3
MATH 224 Elementary Differential Equasions	2S	3
M-group I [3]	2	3
M-group II [3]	3	3
M-group III [3]	4	3
ENGR 131 Elementary Computer Programming [4]	1	3
CHEM 105 or 111 Principles of Chemistry. I	1	3 (4)
CHEM 106 or ENGR 145 Principles of Chemistry II	1	3 (4)
CHEM 113 Principles of Chemistry Laboratory	1	2
SAGES First/University Seminar	1, 2	10
PHED Physical Education Activities (two semesters)		0
Breadth requirements [5]		12
Open electives [6]		16
Total		**127**

1. "Year" indicates the year in which the course usually taken; F or S indicates that a course is offered only in the fall or spring, respectively.
2. PHYS 302 will likely fulfill the SAGES Departmental Seminar requirement.
3. M-group I, II and III are to be chosen from among approved advanced mathematics or statistics courses.
4. Another computational course may be taken with approval.
5. The breadth requirements include six hours of social sciences and six hours of arts and humanities. This may increase by three credits if the required global and cultural diversity course is not also one of the breadth requirement courses. Courses required for the B.S. in physics satisfy the six credit GER for natural and mathematical sciences as well as the quantitative reasoning course requirement.
6. The number of open electives may vary as determined by the degree requirement that the total number of credits be at least 127.

BACHELOR OF SCIENCE IN MATHEMATICS AND PHYSICS

In contrast to an applied mathematics degree or the B.S. in physics with a mathematical physics concentration, this is a synergistic, coherent and parallel education in mathematics and physics. A graduate in this program will understand theory and applications in both mathematics and physics and may endeavor to work and make advances in either field. To a close approximation, the challenging coursework corresponds to combining the mathematics and physics cores, with the physics laboratory cluster replaced by a single senior-year laboratory semester.

Also required is a two-semester senior research project under the guidance of a faculty member from either department. The general education requirements (GER), a computer science course, a chemistry sequence and laboratory, and open electives round out the curriculum. A student in this program may use either of two official advisers, one from each department, who would also constitute a committee for the administration of the degree and the approval of curriculum petitions. Not only an excellent preparation for either mathematics or physics graduate schools, the B.S. in mathematics and physics is quite suitable for careers in industry. The breadth of its training, from pure mathematical analysis to a hands-on instrumentation experience, is uniquely attractive. It is appropriate for computational science and professional and graduate schools where an excellent education in logical thinking and an in-depth, broad technical problem-solving ability are prized.

Course	Year [1]	Cr.
PHYS 121 or 123 Physics I Mechanics	1	4
PHYS 122 or 124 Physics II Electricity & Magnetism	1	4
PHYS 221 Introduction to Modern Physics.	2	3
PHYS 310 Classical Mechanics	2S	3
PHYS 313 Thermodynamics & Stat. Mech.	3F	3
PHYS 331 or 481 Quantum I	3F	3
PHYS 332 or 482 Quantum II.	3S	3
Select one of the following courses:		
PHYS 315 Introduction to Solid State Physics	F	3
PHYS 316 Intro. to Nuclear and Particle Physics	S	3
PHYS 326 Physical Optics	S	3
PHYS 327 Quantum Electronics	F	3
PHYS 328 Cosmology & Structure of the Universe.	S	3
PHYS 336 Modern Cosmology	S	3
PHYS 365 General Relativity	F	3
PHYS 423 Advanced Electricity & Magnetism	4F	3
PHYS 472 Grad Lab	4S	3
MATH 121 or 123 Calculus I	1	4
MATH 122 or 124 Calculus II	1	4
MATH 223 or 227 Calculus III	2	3
MATH 224 Elementary Differential Equasions	2	3
MATH 307 Algebra I.	2F	3
MATH 308 Algebra II	2S	3
MATH 321 Analysis I.	3F	3
MATH 322 Analysis II	3S	3
MATH 324 Complex Variables	3S	3
MATH 321 Analysis I.	3F	3
MATH 322 Analysis II	3S	3

Course	Year [1]	Cr.
MATH 324 Complex Variables	3S	3
MP group I [2].	2	3
MP group II [2]	3	3
MP group III [2].	3	3
MP group IV [2].	4	3
PHYS 351 or MATH 351 Senior Project (SAGES Capstone)	4	6
ENGR 131 Elementary Computer Programming [3].	1	3
CHEM 105 or 111 Principles of Chemistry I [4]	1	3 (4)
CHEM 106 or ENGR 145 Principles of Chemistry II [4].	1	3 (4)
CHEM 113 Principles of Chemistry Laboratory	1	2
SAGES First/University Seminar	1, 2	10
PHED Physical Education Activities (two semesters)		0
Breadth requirements [5].		12
Open electives [6]		20
Total		**127**

1. "Year" indicates the year in which the course usually taken; F or S indicates that a course is offered only in the fall or spring, respectively.
2. The MP group of four courses corresponds to two physics courses and two mathematics courses. The physics courses are chosen from PHYS 250, 349, and 350. The mathematics courses are subject to approval by the advisory committee and are hence referred to as approved electives. They may be chosen from the general list of mathematics courses at the 300 level or higher. It may also be possible to choose a course outside the mathematics and physics departments as a substitute in the MP group, subject to approval by the advisory committee.
3. Another computational course may be taken with approval.
4. If approved, other science sequence courses may be substituted.
5. The breadth requirements include six hours of social sciences and six hours of arts and humanities. This may increase by three credits if the required global and cultural diversity course is not also one of the breadth requirement courses. Courses required for the B.S. in physics satisfy the six credit GER for natural and mathematical sciences as well as the quantitative reasoning course requirement.
6. The number of open electives may vary as determined by the degree requirement that the total number of credits be at least 127.

BACHELOR OF SCIENCE IN ENGINEERING, MAJOR IN ENGINEERING PHYSICS

Students majoring in engineering physics complete the Case School of Engineering's core curriculum requirements as well as a rigorous course of study in physics. Students select a concentration area from an engineering discipline, and must complete a sequence of at least four courses in this discipline. In addition, a senior research project under the guidance of a faculty member is required. The project includes a written report and participation in the senior symposium.

The mission of the engineering physics program is to prepare students for careers in engineering where physics principles can be applied to the advancement of technology. This education at the intersection of engineering and physics will enable students to seek employment in engineering upon graduation while, at the same time, provide a firm foundation for the pursuit of graduate studies in either engineering or physics. The engineering physics program will develop sufficient depth in both engineering and physics skills to produce engineers who can relate fundamental physics to practical engineering problems, and will possess the versatility to address new problems in our rapidly changing technological base. The program will provide a curriculum and environment to develop interdisciplinary collaboration, ethical and professional outlooks, communication skills and the tools and desire for life-long learning. In order to realize this mission, the engineering physics program will pursue the following objectives:

Program Objective 1 Graduates of the engineering physics program will apply their strong problem solving skills as physicists along with an understanding of the approach, methods and requirements of engineering and engineering design for a successful career in advancing technology

Program Objective 2: Graduates of the engineering physics program will use their strong skills in problem solving, research experience and knowledge in physics and engineering as successful graduate students and researchers in highly ranked graduate programs.

Engineering Core and Science Requirements

PHYS 121/123 .....Physics I
PHYS 122/124 .....Physics II
PHYS 221/223 .....Physics III
MATH 121 .....Calculus for Science and Engineering I
MATH 122 .....Calculus for Science and Engineering II
MATH 223 .....Calculus for Science and Engineering III
MATH 224 .....Elementary Differential Equations
CHEM 111 .....Principles of Chemistry for Engineers
CHEM 113 .....Principles of Chemistry Laboratory
ENGR 131 .....Elementary Computer Programming
ENGR 145 .....Chemistry of Materials
ENGR 200 .....Statics and Strength of Materials
ENGR 210 .....Introduction to Circuits and Instrumentation
ENGR 225 .....Thermodynamics, Fluid Dynamics, Heat and Mass Transfer
ENGL 150.....Expository Writing
Humanities and social science 21 hours including three hours in professional communications

Physics Courses

PHYS 208 .....Instrumentation and Signal Analysis Laboratory
PHYS 250 .....Mathematics, Physics and Computing
PHYS 303 .....Advanced Physics Laboratory Seminar
PHYS 310 .....Classical Mechanics
PHYS 313 .....Thermodynamics and Statistical Mechanics
PHYS 315 .....Introduction to Solid State Physics
PHYS 317 .....Engineering Physics Laboratory I
PHYS 318 .....Engineering Physics Laboratory II
PHYS 324 .....Electricity and Magnetism I
PHYS 325 .....Electricity and Magnetism II
PHYS 331 .....Introduction to Quantum Mechanics I
PHYS 352 .....Senior Physics Project Seminar
PHYS 353 .....Engineering Physics Senior Project

Applications of Quantum Mechanics

Choose one of the following courses:

PHYS 332 .....Introduction to Quantum Mechanics II
PHYS 327 .....Quantum Electronics
EEAP 321 .....Physical and Solid State Electronics
EEAP 420 .....Solid State Electronics I
EMSE 314 .....Electrical, Magnetic and Optical Properties of Materials
EMSE 405 .....Dielectric, Optical and Magnetic Properties of Materials

Engineering Physics Concentration (12 hours required)

The engineering physics concentration and senior project topic will be drawn from an engineering discipline. The discipline need not coincide with a specific engineering degree program, but the engineering physics committee must approve courses and project topics selected by individual students. Concentration area courses have been approved in the following areas: aerospace engineering; control systems and automation; biomedical engineering electrical engineering; chemical engineering macromolecular science; civil engineering materials science and engineering; computer science mechanical engineering; computer systems hardware; signal processing; computer systems software; and systems analysis and decision making.

Contact the department for suggested courses and additional information.

BACHELOR OF SCIENCE IN PHYSICS, BIOPHYSICS CONCENTRATION

This concentration addresses the growing interest and excitement in biophysics. It offers ideal preparation for biological research in physics graduate schools and industry, and is appropriate for other graduate departments such as biology, biophysics and biomedical engineering, and as a medical school track. The degree is a track within the B.S. in physics. Thus the program can be described in terms of certain substitutions in the requirements for the standard B.S. in physics. A biogroup of five courses and a technical elective replace four physics courses and two open electives. All substitutions must be approved by a physics faculty committee.

Course	Year [1]	Cr.
PHYS 121 or 123 Physics I, Mechanics	1	4
PHYS 122 or 124 Physics II, Electricity & Magnetism	1	4
PHYS 221 Introduction to Modern Physics	2	3
PHYS 203 Analog and Digital Electronics	2F	4
PHYS 204 Advanced Instrumentation Lab	2S	4
PHYS 250 Mathematics, Physics, and Computing	2S	3
PHYS 310 Classical Mechanics	2S	3
PHYS 301 Advanced Laboratory Physics I [2]	3F	4
PHYS 313 Thermodynamics & Stat. Mech.	3F	3
PHYS 331 Introduction to Quantum Mechanics I	3F	3
PHYS 324 Electricity and Magnetism I	3S	3
Technical elective [3]	4F	3
PHYS 325 Electricity and Magnetism II.	4F	3
PPHYS 351 Senior Project (SAGES Capstone)	4	4
PHYS 352 Senior Project Seminar	4	2
MATH 121 or 123 Calculus I	1	4
MATH 122 or 124 Calculus II	1	4
MATH 223 or 227 Calculus III	2F	3
MATH 224 Elementary Differential Equasions	2S	3
B-group I - V [4]	1-4	15-18
ENGR 131 Elementary Computer Programming [5]	1	3
CHEM 105 or 111 Principles of Chemistry I	1	3 (4)
CHEM 106 or ENGR 145 Principles of Chemistry II	1	3 (4)
CHEM 113 Principles of Chemistry Laboratory	1	2
SAGES First/University Seminar	1, 2	10
PHED Physical Education Activities (two semesters)		0
Breadth requirements [6]		12
Open electives [7]		20
Total		**127**

1. "Year" indicates the year in which the course usually taken; F or S indicates that a course is offered only in the fall or spring, respectively.
2. PHYS 301 will likely fulfill the SAGES Departmental Seminar requirement.
3. Suggested technical electives include PHYS 315, 316, 326, 327, 328, 336, 365.
4. B-group I - V are to be chosen from among approved biology, biophysics, biochemistry, biomedical engineering courses, including certain prerequisites as needed (e.g., chemistry). BIOL 214 and BIOL 215 are suggested for B-group I and II. The listing of credits includes numbers for the most likely choices of courses and, in parenthesis, possible alternatives.
5. Another computational course may be taken with approval.
6. The breadth requirements include six hours of social sciences and six hours of arts and humanities. This may increase by three credits if the required global and cultural diversity course is not also one of the breadth requirement courses. Courses required for the B.S. in physics satisfy the six credit GER for natural and mathematical sciences as well as the quantitative reasoning course requirement.
7. The number of open electives may as long as the total number of credits is at least 127.
8. PHYS 322, PHYS 327, EEAP 321, EEAP 420, EMSE 314 or EMSE 405.

FOR MORE INFORMATION

General Bulletin
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Office of Undergraduate Admission
Phone: 216/368-4450
E-mail: admission@case.edu
Web site: http://admission.case.edu

Case Western Reserve University
10900 Euclid Avenue
Cleveland, OH 44106