

Physics

Department of Physics

Physics
College of Arts and Sciences
239 Fronczak Hall
North Campus
Buffalo, NY 14260-1500

PH: 716.645.2017
Fax: 716.645.2507
Web: www.physics.buffalo.edu

Overview

Physics is the fundamental science underlying the investigation of all natural phenomena. It has provided much of the theory and many of the experimental techniques that are widely used in present-day science and technology. The impressive list of developments that have come directly from physics includes: solid-state electronics; lasers and masers; the nuclear magnetic resonance techniques used in biology, chemistry, and medicine; X-ray crystallography; electron microscopy; and superconductivity.

Physics has also provided a stimulus to philosophy and to the general development of the ideas that seek to explain our relation to the rest of the universe.

About our Degrees

Acceptance Criteria - Physics, BS

Minimum GPA of 2.0 in [MTH 141-MTH 142](#) and [PHY 107-PHY 108](#) (or [PHY 117-PHY 118](#), preferred), [PHY 158](#).

Acceptance Criteria - Mathematical Physics, BS

Minimum GPA of 2.5 in [MTH 141-MTH 142](#) and [PHY 107-PHY 108](#) (or [PHY 117-PHY 118](#), preferred), [PHY 158](#).

Acceptance Criteria - Physics, BA

Minimum GPA of 2.0 in [MTH 141-MTH 142](#) and [PHY 107-PHY 108](#) (or [PHY 117-PHY 118](#), preferred), [PHY 158](#).

Acceptance Criteria - Teaching of Science Program, BA

Minimum GPA of 2.0 in [MTH 141-MTH 142](#) and [PHY 107-PHY 108](#) (or [PHY 117-PHY 118](#), preferred), [PHY 158](#). Teacher Education Institute (TEI) also requires a minimum GPA of 3.0 overall for admission.

Acceptance Criteria - Physics, Minor

Minimum GPA of 2.0 in [MTH 141-MTH 142](#) and [PHY 107-PHY 108](#) (or [PHY 117-PHY 118](#), preferred), [PHY 158](#).

Acceptance Criteria - Other Physics Programs

The Department of Physics participates in the joint majors in Computational Physics and Engineering Physics. There is also a 5-year BS in Computational Physics/MS in Physics program. For the acceptance criteria, see the Computational Physics and Engineering Physics entries.

Acceptance Information

In order to get into any of the undergraduate degree programs students should contact the Undergraduate Director, Professor Bernard Weinstein, 209 Fronczak Hall, (716) 645-6730 (3645), email phyugadv@buffalo.edu. There are no application deadlines. Each year about 15-20 students are accepted into one of the undergraduate degree programs. At present there are about 50 majors in the BS and BA programs in physics and another 30-35 in the interdisciplinary programs (Computational Physics, Engineering Physics, Mathematical Physics).

Degree Requirements

Please see [Degrees and Policies](#).

About our Courses

Physics

The department offers lecture courses, lecture/lab courses, and lab courses. The courses taken by just physics majors typically have 10 to 20 students in them. TA's are only used as recitation or lab instructors in the introductory courses. Students interested in pursuing a degree in physics should begin by taking [MTH 141-MTH 142](#) and [PHY 107-PHY 108](#) (or [PHY 117-PHY 118](#), preferred) and [PHY 158](#) or an equivalent honors course. This is particularly important for [PHY 107](#) and [PHY 108](#), which have [PHY 117](#) and [PHY 118](#) as their equivalent honors courses (preferred), and are designed to benefit physics majors and strong engineering students.

For course descriptions, please see [Courses](#).

About our Faculty

The faculty is comprised of approximately equal number of theorists and experimentalists. Faculty are involved in all areas of physics including condensed matter physics, biophysics, high energy physics, and astrophysics/cosmology.

Five faculty members have received the SUNY Chancellor's Award for Excellence in Teaching, and eight are Fellows of the American Physical Society.

The Director of Undergraduate Studies is Professor Bernard Weinstein who can be contacted at phyugadv@buffalo.edu, 716-645-6730 (3645) or 209 Fronczak Hall.

See a list of our [Undergraduate Faculty](#).

Acceptance Information

It is necessary to apply for acceptance into any of the above programs. The acceptance criteria for students who have completed the relevant coursework at UB are given with the summaries for each degree program. Students who receive a 4 or 5 on the Physics C Mechanics AP exam, and the Physics C Electricity and Magnetism AP exam, can get credit for [PHY 107](#) General Physics 1 and [PHY 108/PHY 158](#) General Physics 2/General Physics 2 Lab, respectively. In general, it is possible to apply for any of the programs in the sophomore year. The undergraduate director, Professor Weinstein, should be contacted at phyugadv@buffalo.edu for acceptance into any of the degree programs except for the BS in engineering physics, which is administered by the School of Engineering and Applied Sciences.

Transfer Policy

1. Transfer students from accredited institutions are granted acceptance to the Department of Physics majors if they satisfy the following requirements with a minimum overall GPA of 2.0:
 - a. one-year calculus-based physics course similar to [PHY 107-PHY 108/PHY 158](#)
 - b. one-year calculus course similar to [MTH 141-MTH 142](#)
2. For transfer students with more than the minimum coursework listed in (1) above, admission is granted if the student has a minimum GPA of 2.0 in all physics and mathematics courses previously attempted.
3. Academic transfer credit is granted for physics and mathematics courses completed with a grade of C or better that are suitable to the department's degree programs.

Extracurricular Activities

Undergraduate Physics Club

This organization is an active group open to all students. It sponsors special speakers and workshops, and organizes open houses and social activities. For more information, call 716-645-2017. Students in the club also belong to the [Society of Physics Students](#) (SPS) which is affiliated with the [American Physical Society](#). Within SPS, students with a GPA above 3.5 are eligible for election to the Sigma Pi Sigma National Physics Honor Society.

See the [UB Student Association](#).

Practical Experience and Special Academic Opportunities

Undergraduate Research and Practical Experience

Physics

Undergraduate physics majors regularly become involved in the research activities of the department. This can involve independent study, part-time employment, and/or full-time employment during the summer.

Interested students should visit <http://www.physics.buffalo.edu/undergraduate/UndergraduateResearchMentors..> This web page describes the undergraduate research mentors program of the physics department. Students earn credit for their undergraduate research in [PHY 498](#) Undergraduate Research.

Honors, Awards, and Scholarships

To graduate with departmental honors, a student must excel in coursework and complete a senior thesis. The designations given below are awarded to students who have the corresponding GPAs in courses required for the Department of Physics degree programs and who have completed a senior thesis:

Distinction 3.25
High honors 3.50
Highest honors 3.75

Outstanding Senior Award

Each year the Department of Physics chooses an outstanding senior. This student receives a certificate and a monetary award from the department, and also receives a College of Arts and Sciences Dean's Outstanding Senior Award.

Sekula Scholarship

Each year the department awards up to seven scholarships to undergraduate physics majors. This award is based on merit, as well as financial need.

Career Information and Further Study

Work settings include:

People with degrees in physics typically pursue careers in teaching or research, or some combination of the two. Teaching can be at the high school, community college, college, or university level. University teachers generally also engage in research. People who pursue a non-teaching research career generally work in industries such as the computer chip industry, or work in government labs such as Argonne or Brookhaven.

Post-undergraduate Opportunities

Approximately 90% of our students go on to graduate school, mostly in physics, but a significant number go into other areas such as law, medicine, biophysics, and medical physics. Our students regularly get into outstanding graduate schools such as Princeton, Cornell, University of Chicago, MIT, and UB.

Degree Options

Other Undergraduate Programs

The Department of Physics participates in joint BS majors in Engineering Physics and Computational Physics. There is also a 5 year BS in Computational Physics/MS in Physics program. For further information see the Engineering Physics and Computational Physics entries.

Advisement

Contact the Department of Physics Director of Undergraduate Studies (DUS), Prof. Bernard Weinstein, phyugadv@buffalo.edu, 645-6730(3645), or in Fronczak 209.

Advanced Placement

Students who receive a 4 or 5 on the Physics C Mechanics exam can get credit for [PHY 107](#) General Physics I. A grade of 4 or 5 on the Physics C Electricity & Magnetism exam provides credit for [PHY 108/PHY 158](#) General Physics 2/Lab.

Degrees Offered

Undergraduate: BA and BS in Physics, BA in the Teaching of Science, BS in Mathematical Physics, Minor in Physics

Graduate: MS, PhD

Links to Further Information About this Program

- [Undergraduate Catalog](#)

Physics

- [Undergraduate Admissions](#)
- [Graduate Admissions](#)
- [Department of Physics](#)
- [College of Arts and Sciences](#)
- [Undergraduate Studies in UB Physics](#)

Physics - B.S.

Acceptance Criteria

Minimum GPA of 2.0 in the prerequisite courses.

Prerequisite Courses

[MTH 141](#) College Calculus I
[MTH 142](#) College Calculus II
[PHY 107](#) General Physics I or [PHY 117](#) Honors Physics I (preferred)
[PHY 108](#) General Physics II or [PHY 118](#) Honors Physics II (preferred)
[PHY 158](#) General Physics II Lab

Required Courses

[CHE 101](#) General Chemistry
[CHE 102](#) General Chemistry
[MTH 241](#) College Calculus III
[MTH 306](#) Introduction to Differential Equations
[MTH 417](#) Survey of Multivariable Calculus
[MTH 418](#) Survey of Partial Differential Equations
[PHY 207](#) General Physics III or [PHY 217](#) Honors Physics III
[PHY 208](#) General Physics IV
[PHY 257](#) General Physics III Lab
[PHY 301](#) Intermediate Mechanics I
[PHY 302](#) Intermediate Mechanics II
[PHY 307](#) Modern Physics Lab
[PHY 401](#) Modern Physics I
[PHY 402](#) Modern Physics II
[PHY 403](#) Electricity and Magnetism I
[PHY 404](#) Electricity and Magnetism II
[PHY 405](#) Thermal and Statistical Physics I
[PHY 406](#) Thermal and Statistical Physics II
[PHY 407](#) Advanced Laboratory or [PHY 408](#) Advanced Laboratory
One PHY elective (one of the following: [PHY 425](#) Intermediate Optics, [PHY 410](#) Computational Physics I, [PHY 412](#) Nuclear and Particle Physics, [PHY 413](#) Electronics, or [PHY 431](#) Introduction to Mathematical Physics I)
One additional 3-credit elective course in physics, another science, engineering, or mathematics at or above the 300-level, as approved by the physics undergraduate director.

Summary

Total required credit hours for the major: 85

See [Baccalaureate Degree Requirements](#) for general education and remaining university requirements.

Recommended Sequence of Program Requirements

FIRST YEAR

Fall [CHE 101](#), [MTH 141](#), [PHY 117](#) (or [PHY 107](#))
Spring [CHE 102](#), [MTH 142](#), [PHY 118](#) (or [PHY 108](#)), [PHY 158](#)

SECOND YEAR

Fall [MTH 241](#), [MTH 306](#), [PHY 208](#)
Spring [PHY 207](#) (or [PHY 217](#)); [PHY 257](#), [MTH 418](#)

THIRD YEAR

Fall [PHY 301](#), [PHY 401](#), [MTH 417](#)
Spring [PHY 302](#), [PHY 307](#), [PHY 402](#)

FOURTH YEAR

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Fall [PHY 403](#), [PHY 405](#), [PHY 407](#) (if [PHY 408](#) is not taken)
 Spring [PHY 404](#), [PHY 406](#), [PHY 408](#) (if [PHY 407](#) is not taken)
 Fall or Spring One PHY elective, plus one 3-credit science-math-eng elective (at or above 300 level) approved by the physics undergraduate director.

Physics - B.A.

Acceptance Criteria

Minimum GPA of 2.0 in the prerequisite courses.

Prerequisite Courses

[MTH 141](#) College Calculus I
[MTH 142](#) College Calculus II
[PHY 107](#) General Physics I or [PHY 117](#) Honors Physics I (preferred)
[PHY 108](#) General Physics II or [PHY 118](#) Honors Physics II (preferred)
[PHY 158](#) General Physics II Lab

Required Courses

[CHE 101](#) General Chemistry
[CHE 102](#) General Chemistry
[MTH 241](#) College Calculus III
[MTH 306](#) Introduction to Differential Equations
[PHY 207](#) General Physics III or [PHY 217](#) Honors Physics III
[PHY 208](#) General Physics IV
[PHY 257](#) General Physics III Lab
[PHY 301](#) Intermediate Mechanics I
[PHY 307](#) Modern Physics Lab
[PHY 401](#) Modern Physics I
[PHY 402](#) Modern Physics II
[PHY 403](#) Electricity and Magnetism I
[PHY 405](#) Thermal and Statistical Physics I
[PHY 407](#) Advanced Laboratory or [PHY 408](#) Advanced Laboratory
 Two PHY electives (choose from [PHY 302](#) Intermediate Mechanics II, [PHY 425](#) Intermediate Optics, [PHY 404](#) Electricity and Magnetism II, [PHY 410](#) Computational Physics I, [PHY 413](#) Electronics, or [PHY 431](#) Introduction to Mathematical Physics I)
 One additional 300/400-level PHY course (excluding [PHY 499](#))

Summary

Total required credit hours for this major: 72

See [Baccalaureate Degree Requirements](#) for general education and remaining university requirements.

Recommended Sequence of Program Requirements

FIRST YEAR

Fall [CHE 101](#), [MTH 141](#), [PHY 107](#) or [PHY 117](#)
 Spring [CHE 102](#), [MTH 142](#), [PHY 108](#) or [PHY 118](#), [PHY 158](#)

SECOND YEAR

Fall [MTH 241](#), [MTH 306](#), [PHY 208](#)
 Spring [PHY 207](#) or [PHY 217](#); [PHY 257](#)

THIRD YEAR

Fall [PHY 301](#), [PHY 401](#)
 Spring [PHY 307](#), [PHY 402](#), one 300/400-level PHY course (excluding [PHY 499](#))

FOURTH YEAR

Fall [PHY 403](#), [PHY 405](#), [PHY 407](#) (if [PHY 408](#) is not taken)
 Spring [PHY 408](#) (if [PHY 407](#) is not taken); two PHY electives

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Mathematical Physics - B.S.

Acceptance Criteria

Minimum GPA of 2.5 in the prerequisite courses.

Advising Notes

Students should consult with the undergraduate director in the physics and mathematics department regarding approved electives.

This is a joint program. A student who follows this program but does not complete it will have difficulty completing a math major without substantial additional coursework.

Prerequisite Courses

[MTH 141](#) College Calculus I
[MTH 142](#) College Calculus II
[PHY 107](#) General Physics I or [PHY 117](#) Honors Physics I (preferred)
[PHY 108](#) General Physics II or [PHY 118](#) Honors Physics II (preferred)
[PHY 158](#) General Physics II Lab

Required Courses

[MTH 241](#) College Calculus III
[MTH 306](#) Introduction to Differential Equations
[MTH 309](#) Introductory Linear Algebra
[MTH 417](#) Survey of Multivariable Calculus
[MTH 418](#) Survey of Partial Differential Equations
[MTH 419](#) Introduction to Abstract Algebra or [MTH 420](#) Advanced Linear Algebra
[MTH 425](#) Introduction to Complex Variables I
[PHY 207](#) General Physics III or [PHY 217](#) Honors Physics III
[PHY 208](#) General Physics IV
[PHY 257](#) General Physics III Lab
[PHY 301](#) Intermediate Mechanics I
[PHY 307](#) Modern Physics Lab
[PHY 401](#) Modern Physics I
[PHY 403](#) Electricity and Magnetism I
[PHY 405](#) Thermal and Statistical Physics I
[PHY 407](#) Advanced Laboratory or [PHY 408](#) Advanced Laboratory
[PHY 431](#) Introduction to Mathematical Physics I (or [MTH 424](#), if offered)
 One 300/400-level MTH elective
 One PHY elective (one of the following: [PHY 302](#) Intermediate Mechanics II, [PHY 402](#) Modern Physics II, [PHY 404](#) Electricity and Magnetism II, or [PHY 406](#) Thermal and Statistical Physics II)

Summary

Total required credit hours for the major: 78

See [Baccalaureate Degree Requirements](#) for general education and remaining university requirements.

Recommended Sequence of Program Requirements

FIRST YEAR

Fall [MTH 141](#), [PHY 107](#) or [PHY 117](#)
 Spring [MTH 142](#), [PHY 108](#) or [PHY 118](#), [PHY 158](#)

SECOND YEAR

Fall [MTH 241](#), [MTH 306](#), [PHY 208](#)
 Spring [MTH 309](#); [PHY 207](#) or [PHY 217](#); [PHY 257](#)

THIRD YEAR

Fall [MTH 417](#), [PHY 301](#), [PHY 401](#)
 Spring [MTH 418](#), [PHY 307](#), one PHY elective

FOURTH YEAR

Fall [MTH 419](#) or [MTH 420](#); [PHY 431](#), [PHY 403](#), [PHY 405](#)
 Spring [MTH 425](#); [PHY 408](#); one 300/400 level MTH elective

Physics

Physics-Teaching Of Science Concentration - B.A.

About the Programs

Students pursuing this concentration must also pursue the Undergraduate Minor in Education, which is administered by the Teacher Education Institute (TEI). Applications to the minor must be filed with the TEI office in 375 Baldy Hall. Applications must include a UB AAR report and/or official transcripts from all other institutions attended other than UB.

This concentration is designed for the student whose career goal is to attain a master's degree for professional certification in science education. Students interested in this concentration should obtain advisement from the director of undergraduate studies in physics and, for questions related to the education courses, from the TEI office.

Completion of the major concentration (including the required education courses) provides advanced status toward Initial New York State Teacher Certification, accomplished through one year of subsequent coursework at the graduate level through the Graduate School of Education. It is then possible to complete, within the state-mandated three years, the master's degree required for a professional teaching certificate, provided all New York State requirements have been successfully completed.

Acceptance Criteria

Minimum GPA of 2.0 in the prerequisite courses. TEI requires a minimum GPA of 2.5 overall for admission.

Teaching of Science - Physics

Prerequisite Courses

[MTH 141](#) College Calculus I
[MTH 142](#) College Calculus II
[PHY 107](#) General Physics I or [PHY 117](#) Honors Physics I
[PHY 108](#) General Physics II or [PHY 118](#) Honors Physics II
[PHY 158](#) General Physics II Lab

Required Courses

[CHE 101](#) General Chemistry
[CHE 102](#) General Chemistry
[MTH 241](#) College Calculus III
[MTH 306](#) Introduction to Differential Equations
[PHY 207](#) General Physics III or [PHY 217](#) Honors Physics III
[PHY 208](#) General Physics IV
[PHY 257](#) General Physics III Lab
[PHY 307](#) Modern Physics Lab
 Four 300/400-level PHY electives (excluding [PHY 499](#))

Summary

Total required credit hours for the major: 57

See [Baccalaureate Degree Requirements](#) for general education and remaining university requirements.

Recommended Sequence of Program Requirements

FIRST YEAR

Fall [CHE 101](#), [MTH 141](#), [PHY 107](#) or [PHY 117](#)
 Spring [CHE 102](#), [MTH 142](#), [PHY 108](#) or [PHY 118](#), [PHY 158](#)

SECOND YEAR

Fall [MTH 241](#), [MTH 306](#), [PHY 208](#)
 Spring [PHY 207](#) or [PHY 217](#); [PHY 257](#)

THIRD YEAR

Fall One 300/400-level PHY elective (excluding [PHY 499](#))
 Spring [PHY 307](#); one 300/400-level PHY elective (excluding [PHY 499](#))

FOURTH YEAR

Fall One 300/400-level PHY elective (excluding [PHY 499](#))
 Spring One 300/400-level PHY elective (excluding [PHY 499](#))

Teaching of Science - Physics and Chemistry

Prerequisite Courses

[MTH 141](#) College Calculus I
[MTH 142](#) College Calculus II

Physics

[PHY 107](#) General Physics I or [PHY 117](#) Honors Physics I
[PHY 108](#) General Physics II or [PHY 118](#) Honors Physics II
[PHY 158](#) General Physics II Lab

Required Courses

[CHE 101](#) General Chemistry
[CHE 102](#) General Chemistry
[CHE 201](#) Organic Chemistry
[CHE 202](#) Organic Chemistry
[CHE 214](#) Introduction to Analytical Chemistry
[MTH 241](#) College Calculus III
[MTH 306](#) Introduction to Differential Equations
[PHY 207](#) General Physics III or [PHY 217](#) Honors Physics III
[PHY 208](#) General Physics IV
[PHY 257](#) General Physics III Lab
[PHY 307](#) Modern Physics Lab
Two 300/400-level PHY electives (excluding [PHY 499](#))

Summary

Total required credit hours for the major: 61

See [Baccalaureate Degree Requirements](#) for general education and remaining university requirements.

Recommended Sequence of Program Requirements

FIRST YEAR

Fall [CHE 101](#), [MTH 141](#), [PHY 107](#) or [PHY 117](#)
Spring [CHE 102](#), [MTH 142](#), [PHY 108](#) or [PHY 118](#), [PHY 158](#)

SECOND YEAR

Fall [MTH 241](#), [MTH 306](#), [PHY 208](#)
Spring [PHY 207](#) or [PHY 217](#), [PHY 257](#)

THIRD YEAR

Fall [CHE 201](#), [CHE 214](#)
Spring [CHE 202](#), [PHY 307](#)

FOURTH YEAR

Fall One 300/400-level PHY elective (excluding [PHY 499](#))
Spring One 300/400-level PHY elective (excluding [PHY 499](#))

Computational Physics - B.S./M.S.

About the Program

This interdisciplinary program is offered jointly by the Departments of Physics (PHY) and Computer Science and Engineering (CSE). For further information, see the [Computational Physics](#) entry.

Engineering Physics - B.S.

About the Program

This interdisciplinary program is offered jointly by the Departments of Physics (PHY) and Electrical Engineering (EE). For further information, see the [Engineering Physics](#) entry.

Physics - Minor

Physics

Acceptance Criteria

Minimum GPA of 2.0 in the prerequisite courses.

Prerequisite Courses

[MTH 141](#) College Calculus I
[MTH 142](#) College Calculus II
[PHY 107](#) General Physics I or [PHY 117](#) Honors Physics I
[PHY 108](#) General Physics II or [PHY 118](#) Honors Physics II
[PHY 158](#) General Physics II Lab

Required Courses

[PHY 207](#) General Physics III or [PHY 217](#) Honors Physics III (lab is not required)
[PHY 208](#) General Physics IV (lab is not required)
[PHY 301](#) Intermediate Mechanics I
[PHY 403](#) Electricity and Magnetism I
 One 300/400-level PHY elective course (excluding [PHY 499](#); [PHY 401](#) Modern Physics I is strongly recommended)

Summary

Total required credit hours for the minor: 33

PHY 100: Introduction to Physics

Credits: 3
Semester(s): Fall, Spring
Type: LEC

Preparation for [PHY 107-PHY 108](#) or [PHY 101-PHY 102](#). Covers mostly Newtonian mechanics, emphasizing problem solving and math skills useful for physics. Reviews algebra, geometry, and trigonometry as applied to physics.

PHY 101: College Physics

Credits: 4
Semester(s): Fall, Spring
Type: LEC/REC

This course is a limited enrollment (impacted) course. Students who have previously attempted the course and received a grade other than W may not register for this course during the fall or spring semester.

Presents non-calculus, introductory physics, including mechanics, heat, waves, and sound. This course is a controlled enrollment (impacted) course. Students who have previously attempted the course and received a grade other than W may repeat the course in the summer or only in the fall or spring semester with a petition to the College of Arts and Sciences Deans' Office.

PHY 102: College Physics II

Credits: 4
Semester(s): Spring
Type: LEC/REC

Presents non-calculus, introductory physics, including electricity and magnetism, light, optics, and modern physics.

PHY 107: General Physics I

Credits: 4
Semester(s): Fall, Spring
Type: LEC/REC

A calculus-based introductory course primarily for chemistry, engineering, and physics majors. Covers kinematics, Newton's laws, energy, momentum, rotational motion, and oscillations.

PHY 108: General Physics II

Credits: 4
Semester(s): Fall, Spring
Type: LEC/REC

A calculus based introductory course primarily for chemistry, engineering, and physics majors. Covers the electric field, Gauss' law, electric potential, capacitance, DC circuits, RC circuits, magnetic field, Faraday's law, inductance, LR circuits, AC circuits, and Maxwell's equations.

PHY 116: Philosophy of Physics

Credits: 3
Semester(s): Spring
Type: LEC

Studies views of space, time, and matter in the ancient world; European post-Renaissance, nineteenth-century ideas and discoveries; wave-particle dualism; wave mechanics; Copenhagen school; theory of relativity; and problems of matter, radiation, and cosmology.

PHY 117: Honors Physics I

Credits: 4

Physics

Semester(s): Spring
Type: LEC/REC

Covers the same topics as [PHY 107](#), but in greater depth. Class size is limited. In general, taken by students in the University Honors College, but other students may take it with permission of instructor.

PHY 118: Honors Physics II

Credits: 4
Semester(s): Fall
Type: LEC/REC

Covers the same topics as [PHY 108](#), but in greater depth. Class size is limited. In general, taken by students in the University Honors College, but other students may take it with permission of instructor.

PHY 119: How Things Work

Credits: 3
Semester(s): Fall
Type: LEC

Describes working principles of devices used in everyday life, such as the video recorder, fax machine, and television. Reviews the history of discoveries that made each device possible, as well as development of the device. Explores the consequences of particular devices in society. Suitable for non-science majors, but science and engineering majors are expected to greatly benefit from it also.

PHY 121: Descriptive Astronomy I

Credits: 3
Semester(s): Fall
Type: LEC/LAB

Introduces astronomy, astronomical instrumentation, the birth and evolution of stars, black holes, constellations and the night sky, covering scales in the universe, the history of astronomy from ancient times to the present, neutron stars, spectroscopy, and white dwarfs.

PHY 122: Descriptive Astronomy II

Credits: 4
Semester(s): Spring
Type: LEC/LAB

A continuation of [PHY 121](#). Covers the Milky Way galaxy, other galaxies in the universe, cosmology and the origin of the universe, the formation of the solar system, earthlike planets, planets of the outer solar system, meteorites, asteroids, and comets. Course themes concentrate on origins: How did the universe begin? What was the origin of the earth? How did life begin?

PHY 151: College Physics I Lab

Credits: 1
Semester(s): Fall
Type: LAB

Studies heat, mechanics, sound, and waves.

PHY 152: College Physics II Lab

Credits: 1
Semester(s): Spring
Type: LAB

Studies electricity and magnetism, light, optics, and modern physics.

PHY 158: General Physics II Lab

Credits: 1
Semester(s): Fall, Spring
Type: LAB

Conducts experiments on mechanics, as well as electricity and magnetism.

PHY 207: General Physics III

Credits: 4
Semester(s): Spring
Type: LEC/REC

Examines sound waves, electromagnetic waves, and geometrical and physical optics. Introduces modern physics, including discovery of the electron, the photon, wave-particle duality, the Bohr model of H-atom, the Schrödinger equation, quantum numbers, the Pauli principle and periodic table, and lasers.

PHY 208: General Physics IV

Credits: 3
Semester(s): Fall
Type: LEC

Examines thermodynamics, including temperature, zeroth law, thermal expansion, specific heat, first law, second law, entropy, third law, kinetic theory, Brownian motion, and the ideal gas. Also explores special relativity, including historical background, Lorentz transformations, length contraction, time dilation, invariance of the laws of physics, relativistic dynamics and kinematics, and paradoxes.

PHY 217: Honors Physics III

Credits: 3
Semester(s): Spring
Type: LEC

Covers the same topics as [PHY 207](#), but in greater depth. Class size is limited. In general, taken by students in the University Honors College, but other students may take it with permission of instructor.

PHY 257: General Physics III Lab

Credits: 1
Semester(s): Spring
Type: LAB

Conducts experiments on waves, geometrical and physical optics,

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and modern physics.

PHY 286: Maple in Physics

Credits: 1
Type: LAB

Introduces basic syntax and capabilities of this computer calculus/algebra system as applied to obtain analytical solutions to problems in physics. Students taking [PHY 386](#) learn the same syntax as [PHY 286](#) students, but are required to do more advanced problems such as occur in junior-senior physics courses. A student may receive academic credit for only one of the two courses.

PHY 301: Intermediate Mechanics I

Credits: 3
Semester(s): Fall
Type: LEC

Vectors, Newtonian mechanics: rectilinear motion of a particle, general motion of a particle in three dimensions, oscillations, Hamilton's variational principle: derivation of Lagrange's equations and Hamilton's equations with simple applications, equivalence to Newtonian dynamics, forces of constraint and the Lagrange multiplier method, generalized forces, noninertial reference systems, gravitation and central forces.

PHY 302: Intermediate Mechanics II

Credits: 3
Semester(s): Spring
Type: LEC

Whenever feasible, the Lagrangian method will be applied. Dynamics of systems of particles, mechanics of rigid bodies: planar motion, motion of rigid bodies in three dimensions, dynamics of oscillating systems.

PHY 307: Modern Physics Lab

Credits: 2
Semester(s): Fall
Type: LAB

Conducts experiments in thermodynamics and modern physics.

PHY 311: Applied Acoustics of Music

Credits: 3
Type: LEC

A general, practical course. Covers the nature of sound; the ear and the hearing process; consonance and dissonance; scales and harmonic series; basic physics of musical instruments; high fidelity systems; and theatre, studio, and room acoustics.

PHY 386: Maple in Physics

Credits: 1
Semester(s): Spring
Type: LAB

Introduces basic syntax and capabilities of the computer calculus/algebra system as applied to obtain analytical solutions to problems in physics. Students taking [PHY 386](#) learn the same syntax as [PHY 286](#) students, but are required to do more advanced problems such as occur in junior-senior physics courses. A student may receive academic credit for only one of the two courses.

PHY 401: Modern Physics I

Credits: 3
Semester(s): Fall
Type: LEC

It is strongly recommended that physics majors take [PHY 401-PHY 402](#) in the junior year, as these courses provide the necessary background for [PHY 406](#), [PHY 407-PHY 408](#), [PHY 410-PHY 411](#), [PHY 412](#), and [PHY 527-PHY 528](#).

Origins of quantum theory, wave function and the uncertainty principle, Schrodinger equation, one-dimensional examples, formalism of quantum mechanics.

PHY 402: Modern Physics II

Credits: 3
Semester(s): Spring
Type: LEC

Angular momentum, three-dimensional problems, hydrogen atom, time-independant perturbation theory, electron spin and fine structure, time-dependent perturbation theory, quantum statistics.

PHY 403: Electricity and Magnetism I

Credits: 3
Semester(s): Fall
Type: LEC

Examines vector calculus, Gauss' law, scalar and vector potentials, Laplace and Poisson's equations, dielectrics, electrostatic and magnetostatic fields, Ampere's law, Faraday's law, and Maxwell's equations.

PHY 404: Electricity and Magnetism II

Credits: 3
Semester(s): Spring
Type: LEC

Undertakes further study of Maxwell's equations, electric and magnetic susceptibilities, electromagnetic radiation, electromagnetic fields from a moving charge, waveguides and transmission lines, Poynting's vector, and Lorentz force. Also examines relativistic invariance.

PHY 405: Thermal and Statistical Physics I

Credits: 3
Semester(s): Fall
Type: LEC

Explores statistics and statistical description of particles; statistical and macroscopic thermodynamics; basic results of classical statistical mechanics and connections with thermodynamics;

Physics

microcanonical, canonical, and grand canonical ensembles; applications to ideal gases, paramagnets, and lattice vibrations; kinetic theory; and phase equilibrium of one-component systems.

PHY 406: Thermal and Statistical Physics II

Credits: 3
Semester(s): Spring
Type: LEC

Covers quantum statistics of ideal Bose and Fermi systems, applications to electrons in metals, blackbody radiation, Bose condensation, neutron stars, interacting systems, lattice vibrations, nonideal gases, ferromagnets, kinetic theory of transport processes, irreversible processes, and fluctuations.

PHY 407: Advanced Laboratory

Credits: 3
Semester(s): Fall
Type: LAB

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Covers modern physics, with a choice of experiments: atomic physics, modern laser optics, solid state, magnetic resonance, X-ray diffraction, scanning probe microscopy, nuclear, or particle physics. Two four-hour labs each week.

PHY 408: Advanced Laboratory

Credits: 3
Semester(s): Spring
Type: LAB

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Covers modern physics, with a choice of experiments: atomic physics, modern laser optics, solid state, magnetic resonance, X-ray diffraction, scanning probe microscopy, nuclear, or particle physics. Two four-hour labs each week.

PHY 410: Computational Physics I

Credits: 3
Semester(s): Fall
Type: LEC

Examines numerical solutions of problems in dynamics, electrodynamics, and quantum and statistical physics. Also examines root-finding, numerical differentiation, quadrature, matrix inversion, and ordinary differential equations. Studies structured programming in FORTRAN 90, C++, or Java; and explores Computer graphics.

PHY 411: Computational Physics II

Credits: 3
Semester(s): Spring
Type: LEC

More advanced physics problems involving partial differential

equations. Numerical simulation and Monte Carlo methods, data analysis and fast Fourier transforms, use of mathematical library routines and computer algebra programs.

PHY 412: Nuclear and Particle Physics

Credits: 3
Semester(s): Spring
Type: LEC

Explores fundamentals of nuclear physics, including interaction of radiation with matter; properties of nuclear forces; nuclear structure described by shell and collective models; nuclear reactions; radioactive decay processes; and properties of elementary particles.

PHY 413: Electronics

Credits: 3
Semester(s): Spring
Type: LAB

Introduces basic concepts of circuit design, impedance, and feedback systems; solid-state components; integrated circuits; digital circuits; and basic instrumentation.

PHY 414: Experimental Techniques

Credits: 2-3
Semester(s): Fall
Type: TUT

Involves individual work with faculty in a research laboratory.

PHY 415: Experimental Techniques

Credits: 2-3
Semester(s): Spring
Type: TUT

Involves individual work with faculty in a research laboratory.

PHY 431: Mathematical Physics I

Credits: 3
Pre-requisites: [MTH 417](#) and [MTH 418](#)
Type: LEC

Fundamentals of mathematical physics. Includes linear and operator algebra, multiple integrals, Fourier series and transforms, calculus of variations, special functions, and partial differential equations. Focuses on specific applications in classical dynamics, quantum mechanics, electrodynamics, and fluid dynamics.

PHY 480: Special Topics in Physics

Credits: 1-3
Semester(s): Fall, Spring
Type: LEC

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Physics

Topics of interest that are not regularly covered in other courses.

PHY 497: Honors

Credits: 1-4

Semester(s): Fall, Spring

Type: TUT

For students who wish to do a senior thesis. Consult the undergraduate director for details.

PHY 498: Undergraduate Research

Credits: 1-3

Semester(s): Fall, Spring

Type: TUT

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Allows students to earn credit for research activities under the direction of a physics faculty member.

PHY 499: Independent Study in Physics

Credits: 1-4

Semester(s): Fall, Spring

Type: TUT

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Involves individual study arranged between a student and a faculty member. Not restricted to students with professional goals in technical areas.