

PHYSICS (PHY) 456

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Chairperson: Daniel Holland.

General Department Information

The Physics Major sequences at Illinois State University are sufficiently flexible to serve the needs of students with any of the following goals: (1) government or industrial research and development, (2) graduate study in Physics, or an allied field such as Engineering, (3) high school Physics/Science teaching, or (4) professional study in intellectual property law, patent law, or medicine.

Physics Programs

Degrees Offered: B.S.

MAJOR IN PHYSICS**Physics Sequence**

- 52 hours required.
- 44 hours in Physics required.
- Required courses: PHY 107, 110, 111, 112, 217, 220, 240, 270, 284, 307, 325, 340, 370, 384; 6 additional hours of 300-level Physics courses chosen from: PHY 320, 330, 355, 375, 380, and 387. NOTE: PHY 375 may be substituted for PHY 370.
- CHE 140 and 141 are required for the major. (3 hours of CHE 140 also count toward Natural Science Alternative (NSA) General Education requirements.)

Computer Physics Sequence

- 47 hours required.
- 44 hours in Physics are required.
- Required courses: IT 254; PHY 107, 110, 111, 112, 217, 220, 240, 270, 284, 307, 318, 325, 388, 390; 6 additional hours of 300-level Physics courses of which at least 1 course must be chosen from PHY 320, 340 and 384; Computer Physics majors should take Natural Science Alternative (NSA) General Education courses.

Engineering Physics Program with University of Illinois

(or Other Approved Engineering University):

- 53 hours required.
- 45 hours in Physics and Engineering re-

quired.

- Required courses: PHY 107, 110, 111, 112, 217, 220, 240, 270, 284, 307; 17 additional hours of approved upper division courses transferred from the chosen engineering university.
- CHE 140 and 141 are also required. (3 hours of CHE 140 also count toward (NSA) General Education requirements.)

Physics Teacher Education Sequence

- 77 total hours required.
- 40 hours in Physics required. Part of entitlement program leading to the science professional educator license with secondary 9-12 endorsement.
- Required courses: PHY 107, 110, 111, 112, 205, 209, 217, 220, 270, 302, 307, 310, 311, 312 and 353. Majors must also take either PHY 240 or 284.
- Supporting courses required (15 hours): BSC 101; CHE 140 and 141; and GEO 100 (BSC 101 and 3 hours of CHE 140 also count toward General Education requirements).
- Professional Education requirements (22 hours): EAF 228 or 231 or 235; PSY 215; TCH 212, 216, 219; STT 399A72 Student Teaching (8 hours).

MINOR IN PHYSICS

- 23 hours in Physics required.
- Required courses: PHY 110, 111, 112; 11 additional hours of electives from 200- or 300-level Physics courses.

CLINICAL EXPERIENCES IN TEACHER EDUCATION

A variety of clinical (pre-student teaching) experiences, as well as student teaching, are included in the teacher candidates professional preparation. Observations, small and large group instruction, tutoring, field experiences, and student teaching are included in the Clinical Experiences Program. The experiences offered prior to student teaching are integral parts of specific college courses. Clinical experiences are provided in off-campus professional development schools, local schools and campus laboratory schools, agencies and other approved non-school settings. The Cecilia J. Lauby Teacher Education Center monitors and documents all clinical experiences. Teacher candidates will show verification of having

completed clinical experiences commensurate with attaining local, state, and national standards. Teacher candidates must provide their own transportation to clinical experience sites.

Candidates are required to provide documentation of meeting all State of Illinois, district, and university requirements in regard to criminal background checks BEFORE beginning any clinical experiences. Criminal background checks must remain current as of the last day of the clinical experience. Candidates should consult with clinical course faculty and the Cecilia J. Lauby Teacher Education Center well in advance of clinical experience to determine specific requirements needed each semester.

The approximate number of clinical hours associated with each course offering can be found with the appropriate course description in this *Undergraduate Catalog*. The following legend relates to the type and kind of activity related to a specific course.

Clinical Experiences Legend

- Observation (including field trips)
- Tutoring one-on-one contact
- Non-instructional assisting
- Small group instruction
- Whole class instruction
- Work with clinic client(s)
- Graduate practicum
- Professional meeting

Physics Courses

102 ATOMS TO GALAXIES NS

3 sem. hrs.

Concepts, history, and methodology of physical ideas such as motion, thermodynamics, electromagnetism, quanta, and relativity with interrelationships and applications. Lecture and lab. May not be taken under the P/NP option. Not for credit major or minor or if had PHY 105, 108, or 110.

105 FUNDAMENTALS OF

PHYSICS

NSA

4 sem. hrs.

Concepts and principles of mechanics, heat, wave motion, electricity, magnetism, and light. Applications to everyday life. Lecture and lab. Intended for students not majoring or minoring in the physical sciences. May not be taken under the P/NP option. Not for credit if had PHY 108, 110 or equivalent.

107 FRONTIERS OF PHYSICS

1 sem. hr.

Introduction to computational and graphical techniques, technical communication skills, and contemporary topics in physics and related fields.

108 COLLEGE PHYSICS I NSA

5 sem. hrs.

Basic principles of mechanics, wave motion, sound and heat, developed with algebra. Includes diverse scientific and technological applications. Lecture and lab. May not be taken under the P/NP option. Not for credit if had PHY 110 or equivalent. Prerequisite: 2 years of high school algebra or equivalent.

109 COLLEGE PHYSICS II

5 sem. hrs.

Electrostatics, electrical currents, magnetism, light and optical instruments, quantum, atomic, and nuclear physics, special relativity. Continuation of PHY 108. Lecture and lab. Not for credit if had PHY 111 or equivalent. Prerequisite: PHY 108 or 110.

110 PHYSICS FOR SCIENCE AND ENGINEERING I NSA

4 sem. hrs.

Basic principles of mechanics, wave motion, and sound, developed with calculus. Includes diverse scientific and technological applications. Lecture and lab. May not be taken under the P/NP option. Not for credit if had PHY 108 or equivalent. Materials charge optional. Prerequisite: MAT 145 or concurrent registration.

111 PHYSICS FOR SCIENCE AND ENGINEERING II

4 sem. hrs.

Electrostatics, electrical current and circuits, magnetism, Faraday's Law, electromagnetic waves, optics. Continuation of PHY 110. Lecture and recitation. Lab (every other week). Not for credit if had PHY 109 or equivalent. Materials charge optional. Prerequisites: PHY 110; MAT 146 or concurrent registration.

112 PHYSICS FOR SCIENCE AND ENGINEERING III

4 sem. hrs.

Thermodynamics, relativity, quantum theory, atomic and nuclear physics. Lecture, demonstrations, discussions, laboratory exercises, computer lab. Lecture and lab. Materials charge optional. Prerequisites: PHY 111; MAT 147 or concurrent registration.

- 117 NUMERICAL REASONING IN NATURE AND TECHNOLOGY QR**
3 sem. hrs.
 Logical, analytical, mathematical, and computational skills important to quantitative understanding of topics in nature and technology. May not be taken under the P/NP option. Prerequisites: MAT 113, 120, 130, or 145.
- 205 ORIGIN OF THE UNIVERSE SMT**
3 sem. hrs.
 Big Bang Theory; observational and theoretical basis for its development; the early universe; and connection between the universe and subatomic particles. Prerequisites: MAT 113, 120, 130, or 145 and PHY 102, 105, 108, or 110.
- 206 CHAOS AND COMPLEXITY SMT**
3 sem. hrs.
 Chaos and complexity science in historical/social context, strange attractors, fractals, and self-organization; diverse applications from weather forecasting to artificial life. Prerequisite: MAT 113, 120, 130, or 145.
- 207 ENERGY AND THE ENVIRONMENT SMT**
3 sem. hrs.
 Scientific, technological, political, and environmental aspects of energy production and use. Special emphasis on renewable energy sources and global climate change. Formerly ENERGY AND CLIMATE CHANGE. Prerequisite: MAT 113, 120, 130, or 145.
- 208 ASTRONOMY AND SPACE SCIENCE SMT**
3 sem. hrs.
 Survey of the solar system, stars, nebulae and galaxies, with the emphasis on physical processes and methods of analysis. Prerequisites: MAT 113, 120, 130 or 145 and PHY 102, 105, 108, or 110.
- 209 INTRODUCTION TO TEACHING HIGH SCHOOL PHYSICS**
1 sem. hr.
 A weekly seminar in which students exchange information and share reflections derived from clinical observations made in area high schools. Clinical Experience: 25 hours. Prerequisites: 10 hours in PHY. Physics Teacher Education major or minor only.
- 211 STATICS**
3 sem. hrs.
 Force systems; equilibrium of two- and three-dimensional systems; trusses, frames, friction; centroids; moments of inertia; hydrostatic pressure; virtual work. Formerly PHY 152. Prerequisites: PHY 110 and MAT 147.
- 217 METHODS OF THEORETICAL PHYSICS**
3 sem. hrs.
 Mathematics applied to physics: multivariate calculus, vector and tensor analysis, curvilinear coordinates, complex numbers, differential equations, numerical methods. Prerequisites: PHY 111; MAT 147.
- 220 MECHANICS I**
3 sem. hrs.
 Newton's laws applied to the study of motion of point masses subjected to viscous, frictional, elastic, central, harmonic, interparticle, and conservative forces. Prerequisites: PHY 112 and MAT 147.
- 240 ELECTRICITY AND MAGNETISM**
3 sem. hrs.
 Electrostatic fields and potentials in vacuum, Gauss' law, electrostatics of dielectrics, magnetostatics, Biot-Savart, Ampere, and Faraday laws, magnetic induction, magnetic materials, and Maxwell's equations. Prerequisite: PHY 217.
- 270 EXPERIMENTAL PHYSICS**
2 sem. hrs.
 Experiments that demonstrate principles of physics. Emphasis on experimental techniques, laboratory practices, data analysis, and the quality of written reports. Prerequisites: PHY 112 and 220.
- 284 QUANTUM MECHANICS I**
3 sem. hrs.
 Blackbody radiation, photoelectric effect, wave-particle duality, uncertainty principles, Schrodinger equation, probability amplitudes, one-dimensional potentials, hydrogen atom. Prerequisites: PHY 112 and MAT 175. PHY 217 or concurrent registration.
- 290 RESEARCH IN PHYSICS**
1-3 sem. hrs.
 An introduction to the scientific discovery process through participation in a departmental research program. 3 hours conference, lab or library research per week for each hour of credit. Multiple enrollments are allowed; maximum 3 hours. Prerequisite: Completion of 20 hours of Physics.

298 PROFESSIONAL PRACTICE IN PHYSICS**1-16 sem. hrs.**

Supervised work experiences in local, state, national, and international businesses, agencies, institutions, and organizations which are planned, administered, and supervised at the departmental level. University-wide coordination is provided through Professional Practice in Student and Alumni Placement Services or through the Office of Clinical Experiences if the experience is in an educational agency or institution. Maximum of 16 hours may be applied toward graduation. Prerequisite: Consent of the department chair or school director.

302 COMPUTER APPLICATIONS IN HIGH SCHOOL PHYSICS**1 sem. hr.**

Applications of computers in teaching of high school physics. Prerequisite: PHY 209 or concurrent registration.

307 SEMINAR IN PHYSICS**1 sem. hr.**

Introduction to Physics literature searching and techniques of oral and written scientific communication, focusing on current topics in Physics. Multiple enrollments are allowed for credit; maximum of 2 hours. Prerequisite: PHY 112.

310 READINGS FOR TEACHING HIGH SCHOOL PHYSICS**3 sem. hrs.**

Essential background readings for teaching high school physics that center around developing scientific literacy in students. Prerequisite: 10 hours in Physics; or graduate standing.

311 TEACHING HIGH SCHOOL PHYSICS**3 sem. hrs.**

Strategies, curricula, and resources for the teaching of high school physics. Application of knowledge of physics, adolescent psychology, and pedagogical theory to secondary teaching. Includes Clinical Experience: 10 hours. Prerequisites: 18 hours in Physics; PHY 310; Grade of C or better in TCH 216 or concurrent registration; or graduate standing.

312 PHYSICS TEACHING FROM THE HISTORICAL PERSPECTIVE**3 sem. hrs.**

Overview of the development of classical scientific thought relating to physical phenomena with applications to pedagogy. Prerequisites: Completion of 20 hours in Physics. Admission to Professional Studies; or graduate standing.

318 METHODS OF COMPUTATIONAL SCIENCE**3 sem. hrs.**

Introduction to a wide variety of computational techniques and their application to problems in chemistry and physics. Also offered as CHE 318. Prerequisites: IT 165; CHE 140; PHY 109 or 111; CHE 360 or PHY 220 or concurrent registration; or consent of the instructor; or graduate standing.

320 MECHANICS II**3 sem. hrs.**

Coordinate transformations, nonlinear oscillations, Hamilton's Principle, Lagrangian and Hamiltonian mechanics, rigid body motion. Prerequisites: PHY 220 and MAT 340; or graduate standing.

325 THERMAL PHYSICS**3 sem. hrs.**

Thermodynamics, kinetic theory, and statistical mechanics with discussion on phase transitions and critical phenomena. Prerequisite: PHY 284.

330 OPTICAL PHYSICS**3 sem. hrs.**

Optical systems, electromagnetic waves, interference and diffraction, quantum optics. Prerequisite: PHY 240.

340 ELECTRICITY AND MAGNETISM II**3 sem. hrs.**

Electrostatic boundary value problems; Maxwell's equations; polarization, reflection, and transmission of electromagnetic waves, waveguides; electromagnetic radiation, fundamentals of antenna theory, relativistic electromagnetism. Prerequisites: PHY 240 and MAT 340.

353 STUDENT TEACHING SEMINAR**1 sem. hr.**

A seminar through which students exchange information, share reflections, and document observations and activities prior to and during student teaching. Clinical Experience: 15 hours. Prerequisite: Consent of the instructor.

355 SOLID STATE PHYSICS**3 sem. hrs.**

Crystal structures, X-ray and electron diffraction, lattice vibrations and thermal properties, binding energy, conduction of electrons, band theory, dielectric and magnetic properties, defects, metals, semiconductors, and insulators. Prerequisite: PHY 325; or graduate standing.

370 ADVANCED EXPERIMENTAL PHYSICS**1 sem. hr.**

Advanced projects in experimental physics. Emphasis on experiment design and execution, advanced experimental techniques, oral presentation, and written reports. Prerequisite: PHY 270.

375 ELECTRONICS FOR SCIENTISTS**3 sem. hrs.**

DC and AC circuit analysis with an introduction to the electrical properties of semiconductors; theoretical and experimental analysis of semiconductor diode, transistor, and operational amplifier circuits. Lecture and lab. Prerequisite: PHY 111; or graduate standing.

380 TOPICS IN CONTEMPORARY PHYSICS**1-3 sem. hrs.**

Recent developments in the fields of atomic, biomolecular, elementary particle, many-body, molecular, nonlinear, nuclear, plasma, and solid-state physics. Multiple enrollments are allowed. Prerequisites: Senior standing only. Consent of the instructor.

380A03 TOPICS IN CONTEMPORARY PHYSICS: NONLINEAR DYNAMICS**1-3 sem. hrs.**

Recent developments in the field of nonlinear dynamics. Prerequisites: Senior standing only. Consent of the instructor.

380A04 TOPICS IN CONTEMPORARY PHYSICS: GENERAL RELATIVITY**3 sem. hrs.**

An introduction to Einstein's Theory of Relativity. Topics will include the geometry of spacetime, Einstein's Equations and gravitational waves. Prerequisite: PHY 240.

380A80 TOPICS IN CONTEMPORARY PHYSICS: BIOPHYSICS OF NEUROLOGICAL SYSTEMS**3 sem. hrs.**

Biophysical principles of cell signaling and communication, including mathematical modeling, computer simulations and hands-on lab activities. Prerequisites: Completion of 75 hours, or graduate standing. Consent of the instructor.

384 QUANTUM MECHANICS II**3 sem. hrs.**

Operator formalism, Dirac bra and ket notation, angular momentum, perturbation theory, applications to laser physics. Prerequisites: PHY 284 and MAT 340; or graduate standing.

387 METHODS OF MATHEMATICAL PHYSICS**3 sem. hrs.**

Finite- and infinite-dimensional vector spaces, matrices and determinants, Fourier analysis, complex analysis, differential equations. Emphasis on physical applications. Prerequisites: PHY 240 and MAT 340 or concurrent registration; or graduate standing.

388 ADVANCED COMPUTATIONAL PHYSICS**3 sem. hrs.**

Application of computational methods to contemporary topics in physics, including nonlinear classical and quantum dynamics or physical problems that involve many degrees of freedom. Prerequisites: PHY 220, 240, 284, and 318 or consent of the instructor; or graduate standing.

390 COMPUTATIONAL RESEARCH IN PHYSICS**1-2 sem. hrs.**

Independent computational project in physics. Prerequisite: PHY 388.