

# PHYSICS

Haughey Hall, Room 211  
269-471-3430  
[physics@andrews.edu](mailto:physics@andrews.edu)  
[physics.andrews.edu](http://physics.andrews.edu)

## Faculty

Margarita C. K. Mattingly, *Chair*  
Gary W. Burdick  
Mickey D. Kutzner  
Tiffany Z. Summerscales  
Stephen C. Thorman

## Emeriti

Ronald L. Johnson, *Director, Physics Enterprises*  
Robert E. Kingman  
S. Clark Rowland

Academic Programs	Credits
BS: Physics	40
BS: Biophysics	40
BS: Physics Education	30
Major in Physics Studies	30
Minor in Physics	20

## Mission

Our mission is to increase the appreciation, understanding and application of physics in the integrated context of scientific rigor, personal ethics and spirituality, and Seventh-day Adventist faith and service.

Physics describes the world in terms of matter and energy and relates phenomena to fundamental law using mathematical representations. Its scope includes systems that range in size from the sub-nuclear to the entire cosmos.

The BS: Physics program supports and enhances professional careers in all the physical sciences, engineering, and the life sciences. Its emphasis on problem-solving also provides a foundation for careers in medicine, business, law, and government.

The BS: Biophysics program prepares the graduate for direct entry into the workforce or advanced studies in medical and bioengineering fields as well as biophysics.

The BS: Physics Education program prepares the graduate for a career in secondary teaching.

The Major in Physics Studies is an add-on degree program that complements any baccalaureate degree without incurring additional general education requirements. It strengthens and expands marketability and interdisciplinary opportunities.

A Minor in Physics complements any baccalaureate degree. It is the minimum requirement for secondary teaching certification in physics. All physics majors and minors desiring certification should consult with the School of Education throughout their program.

## Undergraduate Programs

### BS: Physics (40)

**Major Requirements:** PHYS241, 242, 271, 272, 277, 377, 411, 430, 431, 477, 481, 495 plus an additional 12 credits numbered 300 and above

**Cognate Courses:** MATH191, 192, 215, 240, 286; CHEM131, 132; and CPTR125 or CPTR151

Physics majors desiring secondary-teaching certification should also consult with the School of Education.

**Recommended Electives:** ELCT141, 142, TCED250

### BS: Biophysics (40)

**Offered by the biology and physics departments**

BIOL165, 166, 371; 372 or BCHM421\*; PHYS241, 242, 271, 272, 277, 377, 411, 416, 430 or CHEM431 and 441, PHYS431, 495

\*A student may earn a minor in chemistry by selecting BCHM421 or CHEM431 and 441.

**Cognate Courses:** CHEM131, 132, 231, 232, 241, 242; MATH191, 192, 286

**Recommended Electives:** BCHM422, 430; CHEM432,442; ELCT141, 142; MATH215, 240

**Senior Thesis.** All Physics and Biophysics majors do some original research in collaboration with an established physicist on-campus or at another university, industrial, or national laboratory. If students enroll for 3 credits of PHYS495 or HONS497, they may prepare a Senior Thesis. Undergraduate Research Assistant (URA) scholarships are available through the Office of Scholarly Research when students collaborate with Andrews Physics faculty.

### BS: Physics Education (30)

**Major Requirements:** PHYS241, 242, 271, 272, 277, 377, 411, 430, 431, 481, 495 plus an additional 6 credits numbered 300 and above in consultation with advisor.

**Cognate Courses:** MATH191, 192, 240, 286; CHEM131

This major is available only to those who are obtaining secondary teacher certification. Pending approval for certification by the state of Michigan.

### Major in Physics Studies (30)

**Major Requirements:** PHYS241, 242, 271, 272, 277, 377, 411 (or ENGR285 and PHYS412), 430, 431 or ENGR435, 481, 495 plus an additional 3.5–6 credits numbered 300 and above in consultation with advisor.

**Cognate Courses:** MATH191, 192, 240, 286

This major is available only as a second major. It is designed to complement engineering, computer science, chemistry and mathematics degrees, but may be added to a major in any field.

### Minor in Physics (20)

PHYS241, 242, 271, 272, 277, 411, and electives chosen in consultation with the department chair. Students in a teacher certification program are required to take PHYS430.

## Graduate Program

The Department of Physics collaborates in the MS: Mathematics and Science program with the departments of Mathematics, Biology, and Chemistry. See the program description under Mathematics & Science.

### Courses

(Credits)

See inside front cover for symbol code.

#### PHYS110

\$ CS (4)

##### *Astronomy*

Exploring the cosmic environment—the solar system, stars and their development, star clusters, the interstellar medium, galaxies, and large-scale features of the Universe. Meets the General Education Physical Science requirement. Does not apply to a major or minor. Weekly: 3 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MATH145 or 166 or STAT285 or MPE P2. *Fall, Spring*

#### PHYS110

V \$ (3)

##### *Astronomy*

AU/GU course—see content above.

#### PHYS115

\$ CS (4)

##### *Mythbusting*

Examining what is commonly believed about the physical world and how to realign it with reality. A conceptual and relevant understanding of physics—forces, matter and energy with 21st century applications. Weekly: 3 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MPE P2 or GE-level math course.

#### PHYS141, 142

\$ (4, 4)

##### *General Physics*

Algebra based introduction to mechanics, relativity, heat, electricity, magnetism, wave motion, physical and geometric optics, and modern physics. Weekly: 3 lectures, 1 recitation, and one 3-hour lab. Prerequisite: A minimum of MATH167 or MATH168 or MPE P4. PHYS142 must be preceded by PHYS141.

#### PHYS225

\$ CS (4)

##### *Sound and Waves*

The production, transmission, synthesis, and perception of sound as understood through the physical principles, properties, and nature of waves. Includes a survey of applications—music, speech, locomotion, and imaging—and comparisons with light and other kinds of waves. Meets the General Education Physical Science requirement. Does not apply to a major or minor. Weekly: 3 lectures and a 2-hour lab. Prerequisite: MATH145 or 166 or STAT285 or MPE P2.

#### PHYS241, 242; PHYS241H, 242H

(4, 4)

##### *Physics for Scientists and Engineers*

An introduction to mechanics, relativity, heat, electricity, magnetism, wave motion, physical and geometric optics, and modern physics emphasizing the mathematical formulation and the physical significance of fundamental principles. Honors credit is available as PHYS241H, 242H. Weekly: 4 lectures and 1 recitation. Prerequisite for PHYS241: MATH191. Corequisite for PHYS241: PHYS271. Prerequisites for PHYS242: MATH192 and PHYS241. Corequisite for PHYS242: PHYS272.

#### PHYS271, 272; PHYS271H, 272H

\$ (1, 1)

##### *Physics for Scientists Laboratory*

Weekly: one 3-hour lab. Honors credit is available as PHYS271H, 272H. Corequisites: PHYS241, 242.

#### PHYS277

(0)

##### *Physics Colloquium*

Current topics and issues of interest to the physics community. Required each semester of all students with a physics major or minor. Weekly: 1 lecture or activity. Repeatable.

#### PHYS280

(0.5–3)

##### *Topics in \_\_\_\_\_*

Introductory-level topics in astrophysics, other current physics area or associated scientific programming. Repeatable to 4 credits. Minimum of 4 hours per week is required for each credit earned. Prerequisite: Approval of the instructor.

#### PHYS295

(1–2)

##### *Independent Study / Research*

Individually directed reading and lab projects (e.g., holography and astrophotography). A minimum of 4 hours per week is required for each credit earned. Repeatable to 4 credits. Prerequisite: Approval of the instructor.

#### PHYS350

Alt (2.5)

##### *Optics*

Geometrical and physical optics; interference and diffraction, polarization, Fourier optics, lasers, and holography. Prerequisites: PHYS242 (recommended) or 142; MATH192.

#### PHYS377

\$ (1)

##### *Advanced Physics Laboratory I*

Development of advanced lab skills in the study of basic physical phenomena. Emphasis includes scientific instrumentation, lab procedure, data reduction, interpretation, and technical communication. Repeatable to 2 credits. *Spring*

#### PHYS400

◆ (1–2)

##### *Demonstrations in Physics*

Identifying topics suitable for demonstration, surveying the literature, preparing demonstrations, finding suppliers of materials and equipment. A critical evaluation of demonstrations—their design, preparation, and execution—with student participation. Prerequisite: Approval of the department chair.

#### PHYS411, 412

◆ Alt (2.5, 2.5)

##### *Theoretical Mechanics*

Statics, kinematics, and dynamics of systems of particles. Application of vector calculus to mechanics; Lagrangian and Hamiltonian formulations. Prerequisite: PHYS242 (recommended) or PHYS142; MATH192. *Fall, Spring* (even years)

#### PHYS416

◆ Alt (2.5)

##### *Biophysics*

Modeling and describing physical phenomena of living systems, including transport and diffusion across membranes and electrical processes in muscle and nerve tissue. Prerequisite: PHYS242 (recommended) or PHYS142; MATH192. *Spring* (odd years)

#### PHYS420

(2–3)

##### *Advanced Topics in \_\_\_\_\_*

Astrophysics, atomic physics, nuclear physics, relativity or other current physics area. Prerequisite: PHYS242 or 411. Repeatable to 6 credits.

#### PHYS430

◆ Alt (2.5)

##### *Thermodynamics and Statistical Mechanics*

Systematic introduction to thermodynamics, kinetic theory, and

statistical mechanics (classical and quantum). Prerequisites: PHYS242 (recommended) or PHYS142; MATH192. *Spring* (odd years)

**PHYS431, 432** ◆ Alt (3, 3)

***Electricity and Magnetism***

A treatment of electromagnetic phenomena in terms of potentials and vector fields. PHYS431 develops Maxwell's equations with descriptions of electrostatics and magnetostatics as solutions to Laplace's and Poisson's equations. PHYS432 addresses electromagnetic radiation in media, reflection and refraction, and the fields of wave guides and antennae. Prerequisite or corequisite: PHYS411. *Fall* (even years), *Spring* (odd years)

**PHYS445** ◆ Alt (2.5)

***Particle Physics***

A study of particle properties, forces, structure, decay and reaction mechanism in the context of the Standard Model. Prerequisite: PHYS481. *Spring* (even years)

**PHYS460** ◆ Alt (2.5)

***Solid State Physics***

A study of crystallography, x-ray diffraction, properties of crystalline and amorphous solids, band theory of solids, and lattice dynamics. Prerequisite: PHYS411.

**PHYS475** (2.5)

***Physics Review***

A review and synthesis of physics concepts and analytical and experimental techniques in preparation for entry into a graduate program. Topics include classical, statistical and quantum mechanics, waves and classical fields. Prerequisite: PHYS411. *Fall*

**PHYS477** ◆ \$ (1)

***Advanced Physics Laboratory II***

Important phenomena, equipment, and techniques in modern experimental physics. Repeatable to 2 credits. *Spring*

**PHYS478** ◆ \$ (0)

***Study Tour:***

Travel to destinations relevant to individual programs of study. Classes will be selected from department(s) offerings. Fee may be required.

**PHYS481, 482** ◆ Alt (3, 3)

***Quantum Mechanics***

The mechanics of small-scale physical phenomena as developed by Heisenberg, Schroedinger, and Dirac. Treatment of square well, step, and harmonic oscillator potentials; uncertainty relations; and symmetries to include angular momenta. Prerequisite or corequisite: PHYS411. *Fall* (odd years), *Spring* (even years)

**PHYS495** (1-3)

***Independent Study/Research***

Individually directed study, problem-solving, or research in selected fields of physics. A minimum of 4 hours work per week is required for each credit earned and a written paper is required. Repeatable to 6 credits. Prerequisite: Approval of the instructor.

**PHYS530** (1-3)

***Topics in Teaching Physics***

Discussions on 1) the principles of physics and effective approaches for teaching them, or 2) the physics lab, its purposes, administrative and safety procedures, essential equipment,

seminal experiments, data analysis, lab journal, and reports. Repeatable to 9 credits.

**PHYS540** (2-3)

***Topics in Physics***

Study in one of the traditional areas of graduate physics such as electromagnetic theory, analytical or quantum mechanics, solid state, atomic, nuclear or high energy physics, astrophysics, relativity, or mathematical physics. Students must complete assigned readings and problems. Satisfactory performance on a written or oral comprehensive exam required. Repeatable to 9 credits.

**PHYS648** (1-3)

***Workshop***

An intensive program for middle school and secondary teachers and teachers-in-training who seek certification or endorsement in physics and who wish to update and expand their skills in the physics laboratory.

**PHYS690** (1-3)

***Independent Study/Research***

Individually directed study, problem-solving, or research in selected fields of physics. Open to qualified students who show ability and initiative. A minimum of 4 hours work per week expected for each credit earned. Repeatable to 6 credits. Prerequisite: Consent of department chair.