PHYSICS

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

Faculty
Margarita C. K. Mattingly, *Chair*
Gary W. Burdick
Mickey D. Kutzner

Emeriti
Robert E. Kingman
Bruce E. Lee
S. Clark Rowland

Academic Programs	Credits
BS: Physics	40
BS: Biophysics	40
Physics as a Second Major	30
Minor in Physics	20

Physics describes the world in terms of matter and energy and relates the many facets of its phenomena in terms of fundamental law. Its scope includes systems that range in size from the subnuclear to the entire cosmos.

A major in physics supports and enhances professional careers in engineering, the life sciences, the physical sciences, and similar areas.

A major in biophysics prepares the graduate for advanced studies in medical and bioengineering fields. Both physics programs prepare the graduate for a career in secondary teaching.

A *second major in physics* is an add-on major that complements other majors without incurring additional general education requirements. It strengthens and expands marketability and interdisciplinary opportunities.

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

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: MATH141, 142, 215, 240, 286; CHEM131, 132; and CPTR125 (FORTRAN) 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—27
CHEM131, 132, 231, 232, 241, 242; MATH141, 142, 286.
Recommended Electives: BCHM422, 430; CHEM432,442; ELCT141, 142; MATH215, 240.

Students electing to take a BS: Biophysics should consult with the chair of the Physics Department. Biophysics majors who are interested in secondary teaching need to select electives to meet certification requirements and should consult with the School of Education early in their programs.

Senior Thesis. Physics and Biophysics majors may elect to perform original research in a topic of mutual interest with a Physics Department faculty member and present this original work in the form of a senior thesis. Students are expected to log a minimum of 180 hours, and may receive up to 3 credits in PHYS495 or HONS497. Research scholarships are available.

BS: Physics as a Second Major—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 upper division elective credits numbered 300 and above in consultation with advisor.
Cognate Courses: MATH141, 142, 240, 286
This major is available only as a second major, to those taking a major in another field.

Minor in Physics—20

PHYS241, 242, 271, 272, 411, and electives chosen in consultation with the department chair.

PHYS110, 115, 405 are not applicable to a major or minor in Physics or a major in Biophysics.

Graduate Program

The Physics Department collaborates in the MS: Mathematics and Physical Science program. See the Interdisciplinary Studies section, p. 141.

Courses

(Credits)

See inside front cover for symbol code.

PHYS110 **$ (3)**
Astronomy
Explores the cosmic environment. Topics include the solar system, stars and their development star clusters, the interstellar medium, galaxies, and the large-scale features of the universe. Meets the natural science elective course requirement. Weekly: 2 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MATH145 or 166 or MPE P3.

PHYS110 **V $ (3)**
Astronomy
AU/HSI course—see content above.

PHYS115 **Alt $ (3)**
Concepts of Physics
A conceptual approach to physics for the non-science student. Explores matter, energy, motion, waves, electricity, and magnetism and quantum physics. Meets the natural science elective course requirement. Weekly: 2 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MATH145 or 166 or MPE P3.

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.

PHYS241, 242 **(4, 4)**
Physics for Scientists and Engineers
An introduction to mechanics, relativity, heat, electricity, magnetism, wave motion, physical and geometrical optics, and modern physics emphasizing the mathematical formulation and the physical significance of the fundamental principles. Weekly: 4 lectures and 1 recitation. Prerequisite for PHYS241: MATH141. Corequisite: PHYS271. Prerequisite for PHYS242: MATH142. Corequisite: PHYS272.

PHYS271, 272 **$ (1, 1)**
Physics for Scientists Laboratory
Weekly: one 3-hour lab. Corequisites: PHYS241, 242.

PHYS277 **(0.5)**
Physics Colloquium
A weekly colloquium highlighting current topics and issues of interest to the physics community. Students register only in the spring semester, but attendance is required in both fall and spring semesters. A faculty mentor is assigned to each student to guide the preparation and presentation of one short talk. Grades are based on attendance and the quality of the presentation and its content. Required of all physics and biophysics majors each year, except those in which PHYS377 or PHYS477 is taken. Repeatable. *Spring*

PHYS280 **(0.5–3)**
Topics in_____
Introductory-level topics in astrophysics or other areas of current interest. Repeatable to 4 credits. Minimum of 4 hours work per week is required for each credit earned. Approval of the instructor is required.

PHYS295 **(1–2)**
Independent Study / Research
Reading and lab projects (e.g., holography and astrophotography). Repeatable to 4 credits. A minimum of 4 hours work per week is required for each credit earned. Approval of the instructor is required.

PHYS350 **Alt (2.5)**
Optics
Geometrical and physical optics; interference and diffraction, polarization, Fourier optics, lasers, and holography. Prerequisites: PHYS242 (recommended) or 142; MATH142.

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.

PHYS400 **✦ (1–2)**
Demonstrations in Physics
Consideration of topics suitable for demonstration, a survey of the literature, prepared demonstrations, suppliers of materials and equipment. A critical evaluation of demonstrations—their design, preparation, and execution—with student participation. Prerequisite: Approval of the department.

PHYS405 **✦ Alt $ (3)**
Acoustics of Music and Hearing
Investigation of the properties of sound with respect to structure of musical sounds, production by musical instruments and human vocal chords, sound intensity and hearing, reverberation, and auditorium acoustics. For persons interested in a better understanding of music, speech, and hearing. Cannot be applied toward a major or minor in physics. Weekly: 2 lectures and a 2-hour lab. Prerequisite: MATH145 or 166 or MPE P3.

PHYS411, 412 **✦ Alt-412 (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; MATH142.

PHYS416 **✦ Alt (2.5)**
Biophysics
Modeling and describing physical phenomena of living systems. Topics deal with transport and diffusion across membranes and electrical processes in muscle and nerve tissue. Prerequisite: PHYS242 (recommended) or PHYS142; MATH142.

PHYS420 **(2–3)**
Advanced Topics in_____
Astrophysics, atomic physics, nuclear physics, relativity or other areas of current interest. 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; MATH142.

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 concurrently enrolled in PHYS411.

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.

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.

PHYS477 **✦ $ (1)**
Advanced Physics Laboratory II
Important phenomena, equipment, and techniques in modern experimental physics. Repeatable to 2 credits.

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 concurrently enrolled in PHYS411.

PHYS495 **(1–3)**
Independent Study/Research
Individually directed study or research in selected fields of physics. Repeatable to 6 credits. A minimum of 4 hours work per week is required for each credit earned. A written paper required. Approval of the instructor required.

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

PHYS690 **(1–3)**
Independent Study/Research
Independent problems of research in selected fields of physics. Open to qualified students who show ability and initiative. Repeatable to 6 credits. A minimum of 4 hours work per week expected for each credit earned. Prerequisite: Consent of department chair.

RELIGION AND BIBLICAL LANGUAGES

Griggs Hall, Room 214
(269) 471-3177
Fax: (269) 471-6258
religion@andrews.edu
http://www.andrews.edu/RELG

Faculty
Keith E. Mattingly, *Chair*
Lael O. Caesar
Glenn E. Russell
Ranko Stefanovic
Woodrow W. Whidden II
Susan P. Zork

Emeriti
Elly H. Economou
A. Josef Greig
S. Douglas Waterhouse

Academic Programs	Credits
BA: Theology	
Pastoral Ministry	68
Secondary Education	54
Youth Ministry	74
BA: Religion	31
BA Distance Degree: Religion	35
AA: Personal Ministries	32
AA Distance Degree: Personal Ministries	32
Minor in Religion	20
Minor in Biblical Languages	22
Minor in Missions	20

Programs

BA: Theology

Choose from one of the following:

Pastoral Ministry Emphasis—68

RELB110, 115, 210, 214, 335, 406, 476; RELH316, 317; HIST404; RELP200 (Twice), 240, 331, 332, 333, 334, 441, 442; RELT100, 226, 250, 308, 340, 400; BIBL211, 212, 311, 312, 321, 322, 427.

Required Cognates (9 credits): HIST404; RELH316, 317.

Minimum grades of C- must be earned in HIST404 and in all RELB, RELH, RELP, and RELT courses that apply to major requirements.

Youth Ministry Emphasis—76

RELB110, 115, 210, 214, 335, 406, 476; RELP200 (Twice), 240, 331, 332, 333, 334, 335, 441, 442; RELT100, 226, 250, 308, 340; BIBL211, 212, 311, 312, 321, 322.

Choose three from ANTH200, BHSC220, FMST454, 456, PSYC204, 251, 252, 319, 454, SOCI120, 345, 415, 430