PHYSICS

Haughey Hall, Room 212
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http://www.andrews.edu/PHYS/

Faculty
Robert E. Kingman, *Chair*
Gary W. Burdick
Mickey D. Kutzner
Margarita C. K. Mattingly
S. Clark Rowland

Academic Programs	Credits
BS: Physics	60
BS: Biophysics	56
Minor in Physics	30

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 sub-nuclear 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.

Undergraduate Programs

BS: Physics—60

Major Requirements: 37 credits in courses numbered 300 and above chosen in consultation with the department faculty, and including PHYS495.

Cognate Courses: Mathematics through calculus MATH171, 172, 173, 281, 282, 283; CHEM121, 122, 123; and COSC125 (FORTRAN).

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

BS: Biophysics—56

Offered by the biology and physics departments
BIOL155, 156, 157, 371; 372 or BCHM401*; BIOL348; PHYS251, 252, 253, 261, 262, 263 (recommended), or 151, 152, 153; 430 or CHEM421; PHYS411.

* A student may earn a minor in chemistry by selecting the biochemistry option and completing an additional 3 credits in chemistry.

Cognate Courses **44**
CHEM121, 122, 123, 211, 212, 213; MATH171, 172, 173, 215 or 281; 216 or 282.

Recommended Electives
BCHM402, 412; CHEM421, 422, 460; COSC125 (FORTRAN); ELCT151, 152, 153, 385; PHYS450.

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 in the sciences to meet certification requirements. Such persons should consult with the biophysics adviser and the School of Education early in their programs.

Minor in Physics— 30

Chosen in consultation with the department including PHYS251, 252, 253, and 261, 262, 263 or 151, 152, 153.

Students majoring in physics are encouraged to take elective courses in electronics and TCED251, and to take at least two of the courses ELCT151, 152, 153. PHYS110, 125, 126, 131, 132, 405 are not applicable to a major or minor in Physics.

Graduate Program

The Physics Department collaborates in the MS: Interdisciplinary Studies (Mathematics and Physical Sciences). See the Interdisciplinary Studies section, p. 86.

Courses

(Credits)

See inside back cover for symbol code.

PHYS110 **$ (4)**
Astronomy
Explores the human 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 science breadth-course requirement. Weekly: 3 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MATH165 or its equivalent.

PHYS110 **V (4.5 qtr; 3 sem)**
Astronomy
Distance education—see content above.

PHYS105 **Alt $ (4)**
Concepts of Physics of Motion
A conceptual approach to physics for the non-science student. Explores matter, energy, and motion. Meets the science breadth-course requirement. Weekly: 3 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MATH165 or equivalent.

PHYS106 **Alt $ (4)**
Concepts of Modern Physics
A conceptual approach to physics for the non-science student. Explores waves, electricity, and magnetism and quantum physics. Meets the science breadth-course requirement. Weekly: 3 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MATH165 or equivalent.

PHYS131, 132 **$ (4,4)**
Applied Physics
Mechanics, heat, electricity, magnetism, acoustics, and optics as applied to technology. Weekly: 3 lectures, 1 recitation, 1 laboratory briefing lecture, and one 3-hour lab. Prerequisite: MATH165.

PHYS151, 152, 153 **$ (4,4,4)**
General Physics
Fundamental concepts of classical and modern physics. Weekly: 3 lectures, 1 recitation, 1 laboratory briefing lecture, and one 3-hour lab. Prerequisite: MATH165.

PHYS251, 252, 253 **(4,4,4)**
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. Prerequisites: MATH171, 172, 173. Corequisites: PHYS261, 262, 263.

PHYS261, 262, 263 **$ (1,1,1)**
Physics for Scientists Laboratory
Weekly: one 3-hour lab. Corequisites: PHYS251, 252, 253.

PHYS280 **(1-4)**
Topics in_____
Introductory-level topics in astrophysics, high-energy physics, or other areas of current interest. Repeatable to 6 credits.

PHYS299 **(1-3)**
Projects in Physics
Reading and lab projects (i.e., holography and astrophotography). Repeatable to 6 credits.

PHYS350 **Alt (4)**
Optics
Geometrical and physical optics; interference and diffraction, polarization, Fourier optics, lasers, and holography. Prerequisites: PHYS253 (recommended) or 153; MATH173. Corequisite: PHYS377 or 477.

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. Students in full-year sequences of upper division physics courses enroll for at least 2 quarters. Repeatable to 3 credits. Prerequisite: PHYS177 or equivalent.

PHYS400 **g (1-4)**
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 g (4)**
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. Prerequisite: MATH165 or equivalent.

PHYS411, 412 **Alt-412 g (4,4)**

Theoretical Mechanics
Statics, kinematics, and dynamics of systems of particles. Application of vector calculus to mechanics; Lagrangian and Hamiltonian formulations. Corequisite: PHYS377 or 477. Prerequisite: PHYS253 (recommended) or PHYS153; MATH173.

PHYS420 **(2-4)**
Advanced Topics in_____
Biophysics, astrophysics, high-energy physics, or other areas of current interest. Prerequisite: PHYS253 or 411. Repeatable to 8 credits.

PHYS430 **Alt g (4)**
Thermodynamics
Systematic introduction to thermodynamics, kinetic theory, and statistical mechanics (classical and quantum). Prerequisites: PHYS253 (recommended) or 153; MATH173. Corequisite: PHYS377 or 477.

PHYS431, 432 **Alt-432 g (4,4)**
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 waveguides and antennae. Prerequisite: PHYS253 or 411. Corequisite: PHYS377 or 477.

PHYS440 **Alt g (4)**
Relativity
A study of the special theory of relativity and an introduction to the general theory of relativity as formulated by Einstein. Prerequisite: PHYS253 or 153; MATH173. Corequisite: PHYS377 or 477.

PHYS450 **Alt g (4)**
Atomic Physics
An introduction to wave mechanics as applied to experimental and theoretical atomic physics. Corequisite: PHYS377 or 477. Prerequisite: PHYS253 or 411.

PHYS460 **Alt g (4)**
Solid State Physics
A study of crystallography, x-ray diffraction, properties of crystalline and amorphous solids, band theory of solids, and lattice dynamics. Corequisite: PHYS377 or 477. Prerequisite: PHYS411.

PHYS470 **Alt g (4)**
Nuclear Physics and Particle Physics
A study of the subatomic phenomena: *nuclear* and particle properties, forces, and structure, as well as decay and reaction mechanisms in the context of currently accepted models. Prerequisite: PHYS450 or 480. Corequisite: PHYS377 or 477.

PHYS477 **$ g (1)**
Advanced Physics Laboratory II
Acquaints students with important phenomena, equipment, and technique of modern experimental physics. Students taking a full-year sequence of upper division physics courses required to enroll for at least 2 quarters. Repeatable to 3 credits.

PHYS480 **Alt g (4)**
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: PHYS411. Corequisite: PHYS377 or 477.

PHYS495 **(1-3)**
Independent Study/Research
Individually directed study or research in selected fields of physics. Repeatable to 9 credits. A minimum of 4 hours work per week and a written paper required for each credit earned. Approval of the instructor required.

PHYS520 **(2-4)**
Concepts in Physics
Study of the important concepts in physics in one of the following areas: mechanics, relativity, electromagnetism, optics, modern physics, elementary particles, and statistical physics. Particular area to be offered determined by demand as negotiated with the department chair. Repeatable to 16 credits. Prerequisite: Science teaching experience.

PHYS530 **(2-4)**
Topics in Teaching Physics
Each time the course is offered, one of the following areas is discussed:
- Principles of physics and effective approaches for teaching them.
- The physics lab, its purposes, administrative and safety procedures, essential equipment, seminal experiments, data analysis, lab journal, and reports.

Repeatable to 8 credits.

PHYS540 **(2,4)**
Topics in Physics
Study of one of the traditional areas of graduate physics such as electromagnetic theory, analytical mechanics, solid state physics, astrophysics, mathematical physics, and theoretical physics. Students must complete assigned readings and problems. Satisfactory performance on a written or oral comprehensive exam required. Repeatable to 8 credits.

PHYS648 **(1-4)**
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 9 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 108
(616) 471-3177
religion@andrews.edu
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Faculty
Keith E. Mattingly, *Chair*
Samuele Bacchiocchi
Lael O. Caesar
A. Josef Greig
Mark B. Regazzi
Ranko Stefanovic
Woodrow W. Whidden II

Academic Programs	Credits
BA: Theology	
Pastoral Ministry	88-91
Secondary Education	54-57
Youth Ministry	93-96
BA: Religion	45-48
BA Distance Degree: Religion	52
Minor in Religion	30
Minor in Biblical Languages	31
Minor in Missions	30

Programs

BA: Theology

Choose from one of the following:

Pastoral Ministry Emphasis 88-91

RELB100, 210, 214, 304, 305, 374, 375, 425, 434, 435; RELH314, 315; HIST404; RELP200, 230, 321, 322, 323, 441, 442; RELT210, 250, 340, 426

Required Cognates: BIBL201, 202, 203, 301, 302, 303, 421, 422. Competence in Greek equivalent to the level represented by BIBL303 is required. Minimum grades of C- must be earned in HIST404 and in all RELB, RELH, RELP, and RELT courses to apply to major requirements.

Youth Ministry Emphasis 93-96

RELB100, 210, 214, 304, 305, 425; three courses from RELB374, 375, 434, 435; HIST404; RELH314, 315; RELP200, 230, 321, 322, 323, 335, 441, 442; RELT340, 426; two courses from BHSC220, PSYC204, 251, 252, 319, 455; two courses from SOCI120, 345, 415, 430; ANTH200; FMST454, 456

Required Cognates: BIBL201, 202, 203, 301, 302, 303, 421. Competence in Greek equivalent to the level represented by BIBL303 is required. Minimum grades of C- must be earned in HIST404 and in all RELB, RELH, RELP, and RELT courses to apply to major requirements.

Secondary-Education Emphasis 54-57