the taxonomies of learning, learning styles, multiple intelligence, and educational technology.

**PTH749**  
*Advanced Concepts in Women's Health Laboratory*  
Advanced practice and application of clinical skills required in the physical therapy assessment and intervention of women’s health. Corequisite: PTH739.

**PTH750**  
*Professional Communication & Consulting*  
An introduction to the integration of the physical therapist as consultant. Discussion will include applying physical therapy consultation services to individuals, business, schools, government agencies and/or other organizations.

**PTH760**  
*Applications in Clinical Research*  
Information presented on how to develop and present a publishable quality case study. It also includes the actual practice of doing an outcomes study in the clinical environment.

**PTH765**  
*Ethical & Legal Issues in Healthcare*  
Contemporary ethical issues are explored, including the relationships among peers, superiors, subordinates, institutions, clients, and patients. Illustrations include actual cases related to Christian biblical principles.

**PTH768**  
*Professional Compendium*  
Summarization of previous or added learning experiences relative to contemporary issues in physical therapy. An overview of the new graduate’s role and responsibility to his/her patients and their families, employer, and community in the expanding physical therapy profession.

**PTH788**  
*Research Project Continuation*  
Non-package, reduced tuition rate applies.

**PTH798**  
*Capstone Experience*  
Serves as an essential outcome component to augment the professional development and new learning that occurs in didactic course work of the postprofessional doctoral degree and demonstrates the ability of the DPT/DScPT to make significant contributions to the profession and/or serve as a change agent in the field of physical therapy.

**PTH799**  
*Research Project (topic)*  
Provides students with guidelines and supervision for data collection, analysis, capstone project preparation and oral presentation.

**PTH880**  
*PT Seminar*  
Preparation of a personal portfolio, assessment of the clinical experiences and preparation for professional licensure.

**PTH881, 882, 883, 884**  
*Clinical Affiliation I, II, III, IV*  
Advanced full-time clinical experience (8-10 weeks each) in a variety of professional practice settings. One of the affiliations must be in outpatient orthopedics, inpatient, and a neurology setting. Thirty-six to forty hours per week. May be repeated.

**Academic Programs**

<table>
<thead>
<tr>
<th>Program</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS: Physics</td>
<td>40</td>
</tr>
<tr>
<td>BS: Biophysics</td>
<td>40</td>
</tr>
<tr>
<td>Physics as a Second Major</td>
<td>30</td>
</tr>
<tr>
<td>Minor in Physics</td>
<td>20</td>
</tr>
</tbody>
</table>

**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  
Tiffany Z. Summerscales  
Stephen C. Thorman  

**Emeriti**

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

**Academic Programs**

- BS: Physics—40
  - Cognate Courses: MATH141, 142, 215, 240, 286; CHEM131, 132; and CPTR125 (FORTRAN or C++) or CPTR151.
  - Physics majors desiring secondary-teaching certification should also consult with the School of Education.

- 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.


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.

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 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 Department of Physics collaborates in the MS: Mathematics and Science with the Departments of Mathematics, Biology, and Chemistry. See the program description under Mathematics and Science, p. 151.

COURSES

See inside front cover for symbol code.

PHYS110

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 physical science general education requirement and may substitute for Scientific Inquiry. Weekly: 3 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MATH145 or 166 or MPE P3.

PHYS110

Astronomy

AU/HSI course—see content above.

PHYS115

Concepts of Physics

A conceptual approach to physics—forces, matter, and energy with 21st century applications. Meets the physical science general education requirement and may substitute for Scientific Inquiry. Weekly: 3 lectures, 1 recitation, and a 2-hour lab. Prerequisite: MATH145 or 166 or MPE P3.

PHYS141, 142

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; PHYS241H, 242H

Physics for Scientists and Engineers


PHYS271, 272; PHYS271H, 272H

Physics for Scientists Laboratory


PHYS277

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

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

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

Advanced Physics Laboratory I

Development of advanced lab skills in the study of basic physical phenomena. Emphasis includes scientific instrumentation, lab procedures, 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.