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 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.

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

<table>
<thead>
<tr>
<th>Academic Programs</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>

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.
PHYS100 Astronomy V $ (3)
AU/HSI course—see content above.

PHYS115 Concepts of Physics Alt $ (3)
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 General Physics $ (4, 4)
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 Physics for Scientists and Engineers (4, 4)

PHYS271, 272 Physics for Scientists Laboratory $ (1, 1)

PHYS277 Physics Colloquium (0.5)
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 (0.5–3)
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 (1–2)
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 Optics Alt (2.5)
Geometrical and physical optics; interference and diffraction, polarization, Fourier optics, lasers, and holography. Prerequisites: PHYS242 (recommended) or 142; MATH142.

PHYS377 Advanced Physics Laboratory I $ (1)
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 Demonstrations in Physics ✦ (1–2)
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 Theoretical Mechanics ✦ Alt-412 (2.5, 2.5)
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 Biophysics ✦ Alt (2.5)
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 Advanced Topics in (2–3)
Astrophysics, atomic physics, nuclear physics, relativity or other areas of current interest. Prerequisite: PHYS242 or 411. Repeatable to 6 credits.

PHYS430 Thermodynamics and Statistical Mechanics ✦ Alt (2.5)
Systematic introduction to thermodynamics, kinetic theory, and statistical mechanics (classical and quantum). Prerequisites: PHYS242 (recommended) or PHYS142; MATH142.

PHYS431, 432 Electricity and Magnetism ✦ Alt (3, 3)
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 Particle Physics ✦ Alt (2.5)
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

<table>
<thead>
<tr>
<th>Academic Programs</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA: Theology</td>
<td>68</td>
</tr>
<tr>
<td>Pastoral Ministry</td>
<td></td>
</tr>
<tr>
<td>Secondary Education</td>
<td>54</td>
</tr>
<tr>
<td>Youth Ministry</td>
<td>74</td>
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<tr>
<td>BA: Religion</td>
<td>31</td>
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<tr>
<td>BA Distance Degree: Religion</td>
<td>35</td>
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<tr>
<td>AA: Personal Ministries</td>
<td>32</td>
</tr>
<tr>
<td>AA Distance Degree: Personal Ministries</td>
<td>32</td>
</tr>
<tr>
<td>Minor in Religion</td>
<td>20</td>
</tr>
<tr>
<td>Minor in Biblical Languages</td>
<td>22</td>
</tr>
<tr>
<td>Minor in Missions</td>
<td>20</td>
</tr>
</tbody>
</table>

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