

200 COLLEGE OF ARTS & SCIENCES

MUPF537	Ladies' Chorus
MUPF538	Chamber Music Ensembles
MUPF545	Sinfonietta
MUPF546	Men's Chorus
MUPF505	Keyboard Accompanying
MUPF510	Collaborative Piano
MUPF515	Recital Accompanying

MUPF550 \$ (1-4)

Private Instruction in _____

Private instruction in composition.

MUPF560 \$ (1-4)

Applied Music Study in Private Lessons (major performance)

Style and development of repertoire; preparation for public performance. Repeatable. Each of these courses require concurrent enrollment in MUPF489.

MUPF575 (1-2)

Recital

MUPF640 (0)

Recital Continuation

Research and Specialized Study

MUHL650 \$ (0)

Project Continuation

Student may register for this title while clearing deferred grade (DG) and/or incomplete (I) courses with advisor approval only. Registration for this title indicates full-time status.

MUHL655 \$ (0)

Program Continuation

Students may register for this non-credit continuation course to maintain active status. For additional information on active status, please refer to p. 56 in the bulletin. Registration does not indicate full-time status.

MUHL665 \$ (0)

Comprehensive Exam Preparation

Advisor approval required. Registration for this title indicates full-time status.

MUHL670 (0)

Comprehensive Exam

MUHL695 (1-2)

Bibliography and Research in Music

An introduction to the tools and materials available in music research, with a critical analysis of sources. An examination of the goals and methods of research in music and an introduction to scholarly writing.

MUHL697 (1-3)

Independent Study and Research in Music

Repeatable.

MUHL698 (2)

Project

Repeatable to 4 credits.

MUHL699 (6)

Master's Thesis

PHYSICS

Haughey Hall, Room 211

269-471-3430

physics@andrews.edu

<http://physics.andrews.edu>

Faculty

Margarita C. K. Mattingly, *Chair*

Gary W. Burdick

G. Brendan Cross

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

Advance the appreciation, understanding and application of physics in the context of personal integrity and service, scientific rigor, and Seventh-day Adventist faith.

Strategies

- Create an environment of scholarly inquiry, learning, and creativity
- Develop technical, analytical, and critical thinking skills
- Provide opportunities for intellectual independence, collaboration, and outreach
- Promote personal wholeness, integrity, balance, and spiritual well-being

Student and Faculty Goals

- Understand physics ideas, principles and interpretation, supporting and participating in research and education
- Measure, analyze and model physical phenomena, lending insight to other disciplines and professions
- Communicate scholarship in written and oral form, networking with scholarly, faith, and civic communities
- Connect scientific and religious world views, serving the Seventh-day Adventist Church and society

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 15 credits numbered 300 and above

*PHYS277 is required every semester. MATH389 may substitute for PHYS277.

Cognate Courses: MATH191 or 195, 192, 215, 240, 286; CHEM131, 132; and CPTR125 or 151 or PHYS235.

Secondary-teaching Certification: Physics majors desiring secondary-teaching certification should also consult with the School of Education. BIOL165 is required in addition to all other cognates. Program is certified by the Michigan Department of Education. Accreditation by the National Science Teachers Association is pending.

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.

**PHYS277 is required every semester. MATH389 may substitute for PHYS277.

Cognate Courses: CHEM131, 132, 231, 232, 241, 242; MATH191 or 195, 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 Scholarships are available through the Office of Research & Creative Scholarship 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.

*PHYS277 is required every semester. MATH389 may substitute for PHYS277.

Cognate Courses: MATH191 or 195, 192, 240, 286; CHEM131; BIOL165.

This major is available only to those who are obtaining secondary teacher certification. Program is certified by the Michigan Department of Education. Accreditation by the National Science Teachers Association is pending.

General Education Requirements—for Physics and Physics Education with Secondary Certification

See professional program requirements, p. 51, and note the following **specific** requirements:

Religion: 12*—RELT100, 225, RELH400 and a 3-credit elective chosen in consultation with your SED advisor

Language/Communication: ENGL115, 215, COMM450

Foreign Language (BA only)—Intermediate Language (4)

History: HIST117, 118

Fine Arts/Humanities: Choose one course from: ARTH220, PHOTO210, Studio Art (3), ENGL255, PHIL224, MUHL214, Ensemble Music (3)

Life/Physical Sciences: see cognate requirements for major

Mathematics: see cognate requirements for major

Computer Literacy: INFS120

Service: EDTE165

Social Sciences: GDPC302 & EDTE228

Fitness Education: HLED120 plus two Fitness Education courses

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.

*PHYS277 is required every semester. MATH389 may substitute for PHYS277.

Cognate Courses: MATH191 or 195, 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)

Minor Requirements: PHYS241, 242, 271, 272, 277*, 411, and electives chosen in consultation with the department chair.

*PHYS277 is required every semester. MATH389 may substitute for PHYS277.

Secondary-teaching Certification: Students in a teacher certification program are required to take PHYS430, PHYS377 and PHYS495 (1) Research. They are also required to take MATH191, CHEM131, and BIOL165 as cognates. Program is certified by the State of Michigan Department of Education. Accreditation by the National Science Teachers Association is pending.

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 Astronomy	\$ (4)	
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: MPE P2 or MATH145 or 166 or STAT285. <i>Fall, Spring</i>		
PHYS110 Astronomy	D \$ (4)	
Interactive online course. Exploring the cosmic environment—the solar system, stars and their development, star clusters, the interstellar medium, galaxies, and large-scale features of the Universe. Includes a distance laboratory component and meets the Andrews General Education Physical Science requirement. Does not apply to a major or minor. The distance equivalent of 3 lectures, 1 recitation, and a 2-hour lab per week. Prerequisite: MPE P2 or MATH145 or 166 or STAT285 or equivalent. <i>Fall, Spring, Summer</i>		
PHYS115 Mythbusting	\$ (4)	
Examining what is commonly believed about the physical world and how to realign it with measurable reality. A conceptual and relevant understanding of physics—forces, matter and energy with 21st century applications. 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: MPE P2 or any GE-level math course.		
PHYS117 Observational Astronomy Laboratory	\$ (1)	
Practical experience and background in observational astronomy with modern optical instruments in laboratory, field or remote facilities. As weather permits, will include sessions at the University observatory with departmental or personal telescopes. A stand-alone laboratory course suitable for students in any major and for the general public. <i>General Education Physical Science credit is limited to transfer students who are articulating a lecture course in astronomy or a Physical Science with 3 or more credits.</i> Does not apply to a major or minor. Weekly: one 3-hour activity.		
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: MPE P4 or MATH167 or 168. PHYS142 must be preceded by PHYS141.		
PHYS225 Sound and Waves	\$ (4)	
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: MPE P2 or MATH145 or 166 or STAT285.		
PHYS235 MATLAB	\$ (2–3)	
An introduction to MATLAB programming with a focus on its application to physics problems. The capabilities of MATLAB are explored in the areas of graphing, data analysis, numerical methods, Fourier analysis, and signal processing. Weekly: 1 lecture/lab 4 hours.		
PHYS241, 242; PHYS241H, 242H Physics for Scientists and Engineers	(4, 4)	
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 or 241H: MATH191 or 195. Corequisite for PHYS241 or 241H: PHYS271 or 271H. Prerequisites for PHYS242 or 242H: MATH192 and PHYS241 or 241H. Corequisite for PHYS242 or 242H: PHYS272 or 272H.		
PHYS271, 272; PHYS271H, 272H Physics for Scientists Laboratory	\$ (1, 1)	
Weekly: one 3-hour lab. Honors credit is available as PHYS271H, 272H. Corequisites: PHYS241, 242 or PHYS241H, 242H.		
PHYS277 Physics Colloquium	\$ (0)	
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. Interchangeable with MATH389.		
PHYS280 Topics in _____	(0.5–3)	
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 Independent Study/Research	(1–2)	
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 Optics	Alt (2.5)	
Geometrical and physical optics; interference and diffraction, polarization, Fourier optics, lasers, and holography. Prerequisites: PHYS242 (recommended) or 142; MATH192.		
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. A public presentation is required. Repeatable to 2 credits. <i>Spring</i>		
PHYS400 Demonstrations in Physics	◆ (1–2)	
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: PHYS142 or 242; 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: PPrerequisite: PHYS142 or 242; 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. A public presentation is required. 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. A written paper and public presentation are 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.

PHYS577 \$ (0, 0.5, 1)
Physics Colloquium

Current topics and issues of interest in the physics community. Required each semester of MS: Mathematics and Science students not enrolled in MSC1575 and whose program includes physics as one of their two areas. For non-zero credit options, includes specialized study and the preparation and delivery of a public presentation. Weekly: 1 lecture or activity. Half credit possible. Repeatable to maximum of 1 credit.

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.