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

MUPF550  Private Instruction in __________  $ (1–4)
Private instruction in composition.

MUPF560  Applied Music Study in Private Lessons (major performance)  $ (1–4)
Style and development of repertoire; preparation for public performance. Repeatable. Each of these courses require concurrent enrollment in MUPF489.

MUPF575  Recital  (1–2)
MUPF640  Recital Continuation  (0)

Research and Specialized Study

MUHL650  Project Continuation  $ (0)
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  Program Continuation  $ (0)
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  Comprehensive Exam Preparation  $ (0)
Advisor approval required. Registration for this title indicates full-time status.

MUHL670  Comprehensive Exam  (0)

MUHL695  Bibliography and Research in Music  (1–2)
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  Independent Study and Research in Music  (1–3)
Repeatable.

MUHL698  Project  (2)
Repeatable to 4 credits.

MUHL699  Master’s Thesis  (6)

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

Student and Faculty Goals
1. Understand physics ideas, principles and interpretation, supporting and participating in research and education
2. Measure, analyze and model physical phenomena, lending insight to other disciplines and professions
3. Communicate scholarship in written and oral form, networking with scholarly, faith, and civic communities
4. 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

Major Requirements: PHYS241, 242, 271, 272, 277*, 377, 411, 430, 431, 477, 681, 495 plus an additional 15 credits numbered 300 and above

*A student may earn a minor in chemistry by selecting BCHM421 or CHEM431 or 441.

**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

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 or 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


*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

Major Requirements: PHYS241, 242, 271, 272, 277*, 377, 411 (or ENGR285 and PHYS412), 430, 431 or ENGR435, 481, 695 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, 260, 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

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.
PHYS110 $ (4)  
_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 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. **Fall, Spring**

PHYS110 D $ (4)  
_Astronomy_
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. **Fall, Spring, Summer**

PHYS115 $ (4)  
_Mythbusting_
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 $ (1)  
_Observational Astronomy Laboratory_
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. _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._ Does not apply to a major or minor. Weekly: one 3-hour lab. Prerequisite: MPE P2 or any GE-level math course.

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: MPE P4 or MATH167 or 168. PHYS142 must be preceded by PHYS141.

PHYS225 $ (4)  
_Sound and Waves_
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 $ (2–3)  
_MATLAB_
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 (4, 4)  
_Physics for Scientists and Engineers_
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 $ (1, 1)  
_Physics for Scientists Laboratory_
Weekly: one 3-hour lab. Honors credit is available as PHYS271H, 272H. Corequisites: PHYS241, 242 or PHYS241H, 242H.

PHYS277 $ (0)  
_Physics Colloquium_
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 (0.5–3)  
_Topics in_________
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 (1–2)  
_Independent Study/Research_
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 Alt (2.5)  
_Optics_
Geometrical and physical optics; interference and diffraction, polarization, Fourier optics, lasers, and holography. Prerequisites: PHYS242 (recommended) or 142; MATH192.

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. A public presentation is required. Repeatable to 2 credits. **Spring**

PHYS400 $ (1–2)  
_Demonstrations in Physics_
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.

**PHYS 411, 412**  
*Theoretical Mechanics*  
Statics, kinematics, and dynamics of systems of particles. Application of vector calculus to mechanics; Lagrangian and Hamiltonian formulations. Prerequisite: PHYS 242 (recommended) or PHYS 142; MATH 192. Fall, Spring (even years)

**PHYS 416**  
*Biophysics*  
Modeling and describing physical phenomena of living systems, including transport and diffusion across membranes and electrical processes in muscle and nerve tissue. Prerequisite: PHYS 142 or 242; MATH 192. Spring (odd years)

**PHYS 420**  
*(2–3)*  
*Advanced Topics in Physics*  
Astrophysics, atomic physics, nuclear physics, relativity or other current physics area. Prerequisite: PHYS 242 or 411. Repeatable to 6 credits.

**PHYS 430**  
*(2.5)*  
*Thermodynamics and Statistical Mechanics*  
Systematic introduction to thermodynamics, kinetic theory, and statistical mechanics (classical and quantum). Prerequisites: PHYS 142 or 242; MATH 192. Spring (odd years)

**PHYS 431, 432**  
*(3, 3)*  
*Electricity and Magnetism*  
A treatment of electromagnetic phenomena in terms of potentials and vector fields. PHYS 431 develops Maxwell’s equations with descriptions of electrostatics and magnetostatics as solutions to Laplace’s and Poisson’s equations. PHYS 432 addresses electromagnetic radiation in media, reflection and refraction, and the fields of wave guides and antennae. Prerequisite or corequisite: PHYS 411. Fall (even years), Spring (odd years)

**PHYS 445**  
*(2.5)*  
*Particle Physics*  
A study of particle properties, forces, structure, decay and reaction mechanism in the context of the Standard Model. Prerequisite: PHYS 481. Spring (even years)

**PHYS 460**  
*(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: PHYS 411.

**PHYS 475**  
*(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: PHYS 411. Fall

**PHYS 477**  
*(1)*  
*Advanced Physics Laboratory II*  
Important phenomena, equipment, and techniques in modern experimental physics. A public presentation is required. Repeatable to 2 credits. Spring

**PHYS 478**  
*$ (0)*  
*Study Tour*  
Travel to destinations relevant to individual programs of study. Classes will be selected from department(s) offerings. Fee may be required.

**PHYS 481, 482**  
*(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: PHYS 411. Fall (odd years), Spring (even years)

**PHYS 495**  
*(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.

**PHYS 530**  
*$ (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.

**PHYS 540**  
*(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.

**PHYS 577**  
*$ (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.

**PHYS 648**  
*(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.

**PHYS 690**  
*(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.