Department of Physics and Astronomy

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The Department of Physics and Astronomy offers students the opportunity to study the fundamental principles and methodologies of theoretical, experimental, and computational physics. The physics core curriculum forms the framework for the Physics major. Each student then completes the rest of the program of study with a variety of electives according to his or her interests and career objectives. The core curriculum, coupled with upper-level electives, provides strong preparation for advanced study in physics or astronomy or a career in industrial physics or engineering or simply lays the foundation for a rigorous undergraduate education, regardless of one's desired field of employment after the baccalaureate degree.

The departmental program of study leads to a Bachelor of Science degree in Physics. Concentrations in Medical Physics and Astronomy are available. Minors in Physics and Electro-Acoustics are also available.

Curricular listings include General Education requirements in Communication, History, Humanities and/or Fine Arts, Mathematics, Natural Sciences, and Social/Behavioral Sciences categories as outlined on pages 64–67.

Major in Physics

The major in Physics consists of 27 semester hours of required core courses, plus 9 hours of upper-division electives in physics and astronomy. The core curriculum consists of PHYS 2110/2111, 2120/2121 (or 2010/2011, 2020/2021), 3100, 3110, 3150, 3610, 3800, 3900, 3910, 4850, and 4900. Also required are CHEM 1110/1111, 1120/1121 and MATH 1910, 1920. The following program is suggested for the first two years. For the third and fourth years, each student should work closely with his/her advisor to tailor a program which will meet individual requirements. A minimum of 12 semester hours in the Physics major must be taken at MTSU.

Recommended Sequence

FRESHMAN		**SOPHOMORE**	
ENGL 1010, 1020 (Comm)	6	COMM 2200 (Comm)	3
PHYS 2110/2111 (Nat Sci)	4	HIST 2010, 2020, or 2030	3
and 2120/2121 OR	4	PHYS 3100, 3110	6
PHYS 2010/2011 (Nat Sci)	(4)	PHYS 3150, 3160	6
and 2020/2021	(4)	CSCI 1170	4
MATH 1910 (Math)	4	Electives	9
MATH 1920	4		**31**
CHEM 1110/1111 (Nat Sci)	4		
CHEM 1120/1121	4		
	30		

Credit may be received for PHYS 2110-2121 or 2010-2021, but not for both series.
Courses satisfying the remaining areas of General Education are to be taken during the junior and senior years.

Concentration: Medical Physics

The Medical Physics concentration is designed to prepare students for graduate work in medical physics and radiation oncology physics, eventually leading to a career as a medical physicist in a clinical or academic setting. In addition to the chemistry, math, and 27-hour core curriculum requirements for the Physics degree, the following courses are also required:

PHYS 3160 Topics and Methods of Theoretical Physics II
PHYS 3600 Radiation Oncology Physics
PHYS 4310 Electricity and Magnetism
PHYS 4330 Modern Optics
PHYS 4380 Introduction to Quantum Mechanics
PHYS 4600 Topics in Medical Physics
PHYS 4950 Modern Physics Laboratory
BIOL 2010/2011 Human Anatomy and Physiology I
BIOL 2020/2021 Human Anatomy and Physiology II

Concentration: Astronomy

The Astronomy concentration is designed to prepare students for graduate work in astronomy or astrophysics. In addition to the chemistry, math, and 27-hour core curriculum requirements for the Physics degree, the following courses are also required:

ASTR 1031 Observing the Universe
ASTR 2030 Solar System Astronomy
ASTR 2040 Stars, Galaxies, and Cosmology
ASTR 3400 Fundamentals of Astrophysics
ASTR 3401 Experimental Astronomy
ASTR 4850 Astronomy Research
ASTR 4900 Astronomy Senior Thesis

Teacher Licensure in Physics

Students seeking a license to teach physics in secondary schools (grades 7-12) must complete (1) a major in Physics, (2) a minor in Secondary Education, and (3) additional teacher licensure requirements. Students can also become licensed to teach physics under the Science major (see page 130).

Additional Teacher Licensure Requirements

In addition to the General Education requirements (see pages 64–67) the following courses are required for teacher licensure in physics:
MATH through 1920
BIOL 1110/1111, 1120/1121 General Biology
CHEM 1110/1111, 1120/1121 General Chemistry I and II
ASTR 1030 Exploring the Universe
PHYS 2010-2021 Non-Calculus-Based Physics/Laboratory OR
PHYS 2110-2121 Calculus-Based Physics/Laboratory
GEOL 1040/1041 Physical Geology

Secondary Education Minor Requirements

Students must contact their Secondary Education minor advisors for approval of appropriate courses.

NOTE: *See Department of Educational Leadership on page 210 for Secondary Education minor requirements.*

Major Requirements

Students who want to teach secondary physics must complete the Physics major in the following manner:
PHYS 2010/2011, 2020/2021 Non-Calculus-Based Physics I OR
PHYS 2110/2111, 2120/2121 Calculus-Based Physics I
PHYS 3100, 3110 Modern Physics I and II
PHYS 3150 Topics and Methods of Theoretical Physics I
PHYS 3310, 3350 Concepts and Applications of Digital and Analog Electronics
PHYS 3610 Thermodynamics
PHYS 3800 Physics Seminar
PHYS 3900 Physics Practicum
PHYS 3910 Advanced Physics Laboratory

Minor in Electro-Acoustics

The minor in Electro-Acoustics consists of at least 21 semester hours, 18 of which are required: MATH 1910; PHYS 1600, 3310, and 3350; and ET 3610. Remaining elective may be chosen from PHYS 3000, ET 3620, or ET 3660.

Minor in Physics

The minor in Physics consists of 19 semester hours in physics and astronomy including PHYS 2110/2111, 2120/2121 (2010/2011, 2020/2021). Students minoring in Physics should work closely with their Physics advisor to tailor a program which meets their needs. At least four upper-division hours must be taken at MTSU.

Courses in Astronomy [ASTR]

1030 Exploring the Universe. Three credits. A general introduction to astronomy through an overview of planets, stars, systems of stars, and the overall structure of the universe. Topics will be discussed by answering questions such as "How do you weigh stars?" and "Will the universe die?"

1031 Observing the Universe. One credit. Prerequisite or corequisite: ASTR 1030. Introduction to observational astronomy through laboratory exercises and outdoor observing activities. Topics include telescopes, the analysis of starlight, and observations of stars and planets.

2030 Solar System Astronomy. Three credits. Prerequisite: MATH 1710. Comprehensive study of the solar system including models

of solar and planetary formation. Analysis of the chemical makeup and physical nature of the Sun, planets, moons, and comets using mathematics and the scientific method. Focus on planetary interiors, surfaces, atmospheres, solar-planetary interactions, and solar system evolution. Discussion of spacecraft missions, future solar system exploration, and possibilities of extraterrestrial life.

2040 Stars, Galaxies, and Cosmology. Three credits. Prerequisite: MATH 1710. A comprehensive study of stellar, galactic, and cosmological astronomy. Analyzes the basic theories of stellar and galactic formation and evolution using mathematics and the scientific method. Includes the cataclysmic topics of supernovae, neutron stars, pulsars, and black holes as well as the nature of galaxies including the Milky Way galaxy, active galaxies and quasars, and the formation and evolution of our universe, the big bang theory, and the possibility of other life in the universe.

3050 Directed Study in Astronomy. One to four credits. Prerequisite: PHYS 2021 or 2120 and approval of department chair. Individualized intensive study of a specific topic in astronomy or astrophysics not normally covered to the extent desired in the standard curriculum. Arrangements must be made with an approved faculty member prior to registration.

3400 Fundamentals of Astrophysics. Three credits. Prerequisite: PHYS 2021 or 2120 and MATH 1910. Modern astronomical knowledge and techniques using classical and modern physical principles. Possible topics include star formation, black holes and neutron stars, galaxy structure and evolution, formation of planetary systems, and large-scale structure of the universe.

3401 Experimental Astronomy. One credit. Prerequisite: Consent of instructor. Principles and techniques of astronomical data acquisition and reduction. Possible research topics involve photometry, spectroscopy, astronomical applications of electronic detectors, and computer modeling.

4800 Special Topics in Astronomy. Three credits. Prerequisites: PHYS 3150 and approval of department chair. In-depth, organized study of a contemporary topic of interest not normally covered in the undergraduate physics and astronomy curriculum. Possible topics include planetary geology, radio astronomy, stellar atmospheres or interiors, space physics, pulsating stars, dark matter and energy, galactic evolution, and general relativity and cosmology.

4850 Astronomy Research. Two credits. Prerequisite: Consent of instructor. Independent study of a selected research problem in astronomy. Includes experimental and/or theoretical investigation of an important yet unexplored problem or experimental design. Includes literature research and experimental design/problem formulation and execution resulting in oral and written presentation of results suitable for submission/presentation to a suitable journal/conference.

4900 Astronomy Senior Thesis. Two credits. Prerequisites: ASTR 4850 and consent of department chair. Focuses on a specific research/experimental design problem chosen with the consent of the thesis committee and with the potential for original discovery or for creative development of a tool, technique, or instrumentation applicable to scientific research. Independent pursuit of research objectives outlined in a research proposal results in a written thesis, the approval of which will include an oral defense.

Courses in Physics [PHYS]

1300 Discovering Physics. Three credits. Prerequisite: MATH 1710 or 1730. Students with weak science or math backgrounds introduced to a variety of topics and their applications. Emphasis on building skills for graphical interpretation of real data within a discovery-learning environment. Presents concepts and techniques of physics for students planning to take PHYS 2010; serves as a good introduction for those interested in learning more about how the world works.

1600 Physics of Music. Three credits. Prerequisite: MATH 1710 or consent of instructor. The physics of music, acoustics, and sound for students without prior physics background.

2010 Non-Calculus-Based Physics I. Zero credit. Prerequisite: MATH 1710 or 1730. Required corequisite: PHYS 2011. Web-based discussion class to be taken in conjunction with cooperative-learning based problems lab PHYS 2011. Classical mechanics traditionally covered in a first-semester college physics course. Kinematics, forces, momentum, angular motion, calorimetry, and sound waves. Class time used for discussion of the Web-lecture material and for the administration of exams.

2011 Physics Problems Laboratory I. Four credits. Prerequisite: MATH 1710 or 1730. Required corequisite: PHYS 2010. Group-oriented problems course taken in conjunction with the Web-based discussion class PHYS 2010. Students work in groups with the topics presented in the PHYS 2010 discussion class. Covers kinematics, forces, momentum, angular motion, calorimetry, and sound waves. Skills associated with the development of experimental investigations including graphical analysis and estimation of uncertainties emphasized. Two two-and-one-half-hour laboratory sessions.

2020 Non-Calculus-Based Physics II. Zero credit. Prerequisites: PHYS 2011. Required corequisite: PHYS 2021. Web-based discussion class taken in conjunction with the cooperative-learning based problems lab PHYS 2021. Fundamentals of optics, modern physics, and electronics traditionally covered in a second-semester college physics course. Reflection and refraction, vision, diffraction effects, quantum mechanics, atomic and nuclear physics, and analog and digital electronics. Scheduled class time is used for discussions of the Web-lecture material and for the administration of exams.

2021 Physics Problems Laboratory II. Four credits. Prerequisites: PHYS 2011. Required corequisite: PHYS 2020. Group-oriented problems course to be taken in conjunction with the Web-based discussion class PHYS 2020. Students work in groups with the topics presented and in the PHYS 2020 discussion class. Optics, modern physics, and electronics traditionally covered in a second-semester college physics course. Reflection and refraction, vision, diffraction effects, quantum mechanics, atomic and nuclear physics, and analog and digital electronics. The skills associated with the development of experimental investigations including graphical analysis and estimation of uncertainties emphasized. Two two-and-one-half-hour laboratory sessions.

2110 Calculus-Based Physics I. Three credits. Prerequisite: MATH 1910. Corequisite: PHYS 2111. A calculus-based introduction to mechanics and wave motion.

2111 University Physics Laboratory I. One credit. Prerequisite: MATH 1910. Corequisite: PHYS 2110. Laboratory course to accompany PHYS 2110. Experiments in mechanics, waves, and thermodynamics. Data reduction, error analysis, and report writing. One three-hour laboratory.

2120 Calculus-Based Physics II. Three credits. Prerequisites: PHYS 2110; MATH 1920. Corequisite: PHYS 2121. A continuation of PHYS 2110. Electricity, magnetism, circuit analysis, and optics.

2121 University Physics Laboratory II. One credit. Prerequisites: PHYS 2110 and 2111. Corequisite: PHYS 2120. Laboratory course to accompany PHYS 2120. A continuation of PHYS 2111. Experiments in electricity, magnetism, optics, and modern physics. Data reduction, error analysis, and report writing. One three-hour laboratory.

3000 Acoustics and Signal Analysis. Three credits. Prerequisites: PHYS 1600 and MATH 1910. Detailed overview of acoustics including an introduction to digital signals and their analysis. Application areas include architectural, musical, and environmental acoustics. Intended for students interested in the technical side of the music industry.

3050 Directed Study in Physics. One to four credits. Prerequisites: PHYS 2021 or 2120 and approval of department chair. Individualized intensive study of a specific topic in physics not normally covered to the extent desired in the standard curriculum. Arrangements must be made with an approved faculty member prior to registration.

3100 Modern Physics I. Three credits. Prerequisites: PHYS 2021 or 2120 and MATH 1920. Introduction to the fundamental principles of modern physics (special relativity and quantum mechanics) and their application to atomic physics.

3110 Modern Physics II. Three credits. Prerequisite: PHYS 3100. Survey of major topics including molecular physics, statistical physics, solid state physics and solid state devices, nuclear models, nuclear decay and reaction, and elementary particle physics.

3111 Modern Physics Laboratory. One credit. Prerequisite or corequisite: PHYS 3110. Concepts and ideas which formed the basis for an understanding of the atom and atomic phenomena. One three-hour laboratory.

3150 Topics and Methods of Theoretical Physics I. Three credits. Prerequisites: PHYS 2021 or 2120 and MATH 1920. Theoretical techniques used for problem solving in physics. Reference frames and coordinate systems, approximation techniques, solution of electrical circuits and mechanical systems, simple harmonic motion and wave motion, Maxwell's equations.

3160 Topics and Methods of Theoretical Physics II. Three credits. Prerequisite: PHYS 3150. A continuation of PHYS 3150. The Schroedinger equation, heat flow, diffusion, the Lagrangian description of motion.

3200 Scientific Modeling and Problem Solving. One credit. Prerequisites: One year of physics and MATH 1920 or consent of instructor. Techniques of computational physics as applied to the solution of scientific problems.

3300 Classical Mechanics. Three credits. Prerequisite: PHYS 3150 (or PHYS 2110 and MATH 3120). Mechanics (including statics and dynamics) of particles in three dimensions using vector analysis, motion of rigid bodies, Lagrangian mechanics, and Hamilton's equations.

3310 Concepts and Applications of Digital Electronics. Three credits. Prerequisite: PHYS 2021 or 2121 or ET 3610. Investigates applications of modern digital technology. Fundamentals of logic gates and programmable devices examined along with contemporary integrated circuits for use in data acquisition and the control of scientific experiments. Sound cards, alarm systems, and laboratory measurement circuits typify projects constructed in the hands-on laboratory. Two hours lecture and one three-hour laboratory.

3330 Health Physics and Radiation Protection. Three credits. Prerequisites: PHYS 2021 or 2120. Radiation protection methods, dosimetry techniques, and survey instruments. Practical knowledge of the methodology for paramedical personnel, industrial workers, and others who deal with radioisotopes and X-ray equipment. Two hours lecture and one three-hour laboratory.

3340 Semiconductor Device Physics. Three credits. Prerequisites: One year physics and MATH 1910. Operation principles of diodes, transistors, and photonic devices. Fundamental band structure investigated to learn how important performance characteristics are related to physical principles. Modern designs include JFET, Bipolar, MOSFET, MODFET, and HEMT transistors.

3350 Concepts and Applications of Analog Electronics. Four credits. Prerequisite: PHYS 2021 or 2121 or ET 3610. Introduction to contemporary analog electronics utilizing integrated circuits to treat traditional circuits, power supplies, operational amplifiers, comparators, and multivibrators. Conversion of analog to digital signal for interfacing to microcomputers. Emphasis on practical applications. Three hours lecture and one three-hour laboratory.

3500 Lasers and Fiber Optics. Three credits. Prerequisites: One year physics and MATH 1910. Operation of fiber optic communication systems; how semiconductor lasers, modulators, and photodetectors work and how they are used in modern communication systems. Hands-on demonstrations and class projects will use lasers and optical components to illustrate basic principles.

3600 Radiation Oncology Physics. Three credits. Prerequisites: MATH 1910 and a one-year introductory sequence in physics. Introduction to the field of radiation oncology physics, including a discussion of the fundamental physics and techniques associated with the diagnosis and treatment of cancer using electromagnetic radiation and particle beams. Includes experiences in a radiation oncology clinic and interactions with practicing medical physicists.

3601 Medical Physics Practicum. One credit. Prerequisite or co-requisite: PHYS 3600. Real-world/clinical applications of concepts and theory from PHYS 3600, especially those associated with detectors and dosimetry. May include hands-on activities at the Vanderbilt-Ingram Cancer Center.

3610 Thermodynamics. Three credits. Prerequisite: PHYS 3110 and 3150 or consent of instructor. Introduction to statistical physics, kinetic theory, and thermodynamics from a unified microscopic point of view. Selected applications to various systems of interest presented.

3800 Physics Seminar. One credit. Prerequisite: PHYS 3100. Develops and refines inquiry, communication, and presentation skills through exposure to new developments in physics, technical brief writing, and resume and job interview preparations.

3900 Physics Practicum. One credit. Prerequisites: PHYS 3100 and consent of instructor. Refines thinking, communication, and interpersonal skills through exposure to on-the-spot technical questions and a laboratory teaching experience as an assistant in an introductory physics laboratory.

3910, 3920 Advanced Physics Laboratory. One credit each. Prerequisites: PHYS 2021 or 2120 and 2121. The skills, art, and physics important in pursuing independent research. Experiments dealing with mechanical, optical, or thermodynamical principles explored.

Report writing, literature research, and the use of analysis tools emphasized.

4310 Electricity and Magnetism. Three credits. Prerequisite: PHYS 3160. Topics including electric and magnetic fields, electrostatic potential, and potential energy and fields in matter, discussed in a mathematically rigorous manner. A variety of good applications of mathematical methods in physics.

4330 Electricity and Magnetism II. Three credits. Prerequisite: PHYS 4310. Topics include theory of electromagnetic radiation, production and propagation of electromagnetic waves, and the solution of boundary-value problems with applications to optics, wave guides, and lasers.

4380 Introduction to Quantum Mechanics. Three credits. Prerequisites: PHYS 3110 and 3160. Topics include both one- and three-dimensional solutions to the Schroedinger equation, including the infinite square-well, finite square-well, tunneling, the harmonic oscillator, and the hydrogen atom with a discussion of angular momentum at a mathematically rigorous undergraduate level.

4600 Topics in Medical Physics. Three credits. Prerequisites: PHYS 3110 and 3160. Topics in medical physics at an advanced undergraduate level. Possible topics include charged-particle interactions and equilibrium in matter, cavity theory, dosimetry, CTs, and MRIs.

4630 Principles of the Solid State. Three credits. Prerequisites: PHYS 3110 and 3150. Includes crystal structures, lattice dynamics, statistics of conductors and semiconductors, thermal properties, the metallic state, free electron theory, band theory of solids, dielectric and magnetic properties of solids, and the low temperature behavior of matter, particularly solids. Three hours lecture.

4800-4810 Special Topics in Physics. Three credits each. Prerequisites: An extensive physics background and permission of instructor. Detailed study of a selected topic of current interest in physics not normally covered in the regular undergraduate physics curriculum. Possible topics include advanced atomic physics, high-energy physics (nuclear and elementary particles), scattering theory, astrophysics, and general relativity.
4800 Special Topics A
4810 Special Topics B

4850-4860 Physics Research. Two credits each. Prerequisite: Consent of instructor. Independent study of a selected research problem in physics. Includes experimental and/or theoretical investigation of an important, yet unexplored, problem. Includes literature research, experiment design/problem formulation and execution, resulting in oral and written presentation of results suitable for submission for publication in a suitable journal.

4900 Physics Senior Thesis. Two credits. Prerequisites: PHYS 4850 and consent of department chair. Brings undergraduate experience to focus on a specific research problem; chosen with the consent of the thesis committee and with the potential for original discovery or for creative development of a tool or technique applicable to scientific research. Independent pursuit of research objectives outlined in a research proposal results in a written thesis whose approval will include an oral defense.

Honors College

The Department of Physics and Astronomy offers the following courses in Honors: ASTR 1030 and 1031. See current class schedule and Honors information in this catalog.