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, 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. The Physics major must be accompanied by one minor of at least 18 semester hours in a subject area of the student's choosing. Minors in Physics and Electro-Acoustics are also available.

Environmental Science and Technology is an interdisciplinary major and minor offered by Agribusiness and Agriscience, Biology, Chemistry, Engineering Technology and Industrial Studies, and Physics and Astronomy. A complete description of the program can be found under the Department of Engineering Technology and Industrial Studies listing in this catalog.

In all curricular listings, (Area __) refers to the General Studies requirements as outlined on pages 59-61.

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 (Area I-A)	6	ENGL 2030, 2--- (Area II-A)	6
PHYS 2110-2121 (2010-2021)	8	PHYS 3100, 3110	6
MATH 1910, 1920	8	PHYS 3150, 3160	6
CHEM 1110, 1111, 1120, 1121	8	CSCI 1170	4
PHED or M S (Area V)	2	Electives	6
	32	PHED or M S (Area V)	2
			30

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

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 professional education, and (3) courses in addition to the General Studies requirements. Students can also become licensed to teach physics under the Science major (see page 112).

Enhanced General Education Requirements

In addition to the General Studies requirements (see pages 59-61) the following courses are required for licensure in physics:
MATH through 3110
CSCI 1160 Fortran Programming
BIOL 1110, 1120 General Biology
CHEM 1110, 1111, 1120, 1121 General Chemistry
ASTR 1030 Exploring the Universe OR
ASTR 3400 Fundamentals of Astrophysics
PHYS 2010-2021 Non-Calculus-Based Physics/Laboratory OR
PHYS 2110-2121 Calculus-Based Physics/Laboratory
GEOL 1040 Physical Geology

Professional Education Requirements

Students must contact their minor advisor in professional education for approval of appropriate courses. (For specific procedures and additional requirements for teacher licensure, see page 184.)

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 3700 Introduction to Environmental Physics
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 (140) 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 (141) 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.

3400 (340) Fundamentals of Astrophysics. Three credits. Prerequisite: PHYS 2020 or 2120. 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 (341) 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.

Courses in Physics [PHYS]

1300 (130) Discovering Physics. Three credits. Prerequisite: MATH 1710. 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 (160) 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 (231) 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 (233) 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 (232) Non-Calculus-Based Physics II. Zero credit. Prerequisites: PHYS 2010 and 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 (234) Physics Problems Laboratory II. Four credits. Prerequisites: PHYS 2010 and 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 (235) Calculus-Based Physics I. Three credits. Prerequisite: MATH 1910. Corequisite: PHYS 2111. A calculus-based introduction to mechanics, wave motion, electricity, magnetism, circuit analysis, and optics.

2111 (237) 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 (236) Calculus-Based Physics II. Three credits. Prerequisites: PHYS 2110 and 2111; MATH 1920. Corequisite: PHYS 2121. A continuation of PHYS 2110.

2121 (238) University Physics Laboratory II. One credit. Prerequisites: PHYS 2110 and 2111 or PHYS 2010 and 2011. 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 (300) 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.

3100 (310) Modern Physics I. Three credits. Prerequisites: PHYS 2020 or 2120 and MATH 1920 or consent of instructor. Introduction to the fundamental principles of modern physics (spe-

cial relativity and quantum mechanics) and their application to atomic physics.

3110 (311) 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.

3150 (315) Topics and Methods of Theoretical Physics I. Three credits. Prerequisites: PHYS 2020 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 (316) 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 (320) 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 (330) 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 (331) Concepts and Applications of Digital Electronics. Three credits. Prerequisite: PHYS 2021 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 (333) Health Physics and Radiation Protection. Three credits. Prerequisites: PHYS 2021 and 2020 or 2120 and 2121. 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 (334) 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 (335) Concepts and Applications of Analog Electronics. Four credits. Prerequisite: PHYS 2020 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 (350) 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.

3610 (361) Thermodynamics. Three credits. Prerequisite: PHYS 3110 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.

3700 (370) Introduction to Environmental Physics. Four credits. Prerequisites: CHEM 1110 and 1111; PHYS 2021 and 2020 (or 2120 and 2121). Energy, energy conversion processes, and radiation and their roles in technological development and the quality of the natural environment. Three hours lecture and one three-hour laboratory.

3800 (380) Physics Seminar. One credit. Prerequisites: PHYS 3150 and consent of instructor. 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 (390) Physics Practicum. One credit. Prerequisites: One year of physics and MATH 1910. 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 (391, 392) Advanced Physics Laboratory. One credit each. Prerequisites: PHYS 2021 and PHYS 2020 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.

4010 (401) Thermometry and Calorimetry. One credit. Prerequisite: PHYS 3610. Temperature measurements and calorimetric determinations. Characteristics, preparation, calibration and use of thermocouples, resistance thermometers, pyrometers, thermistors, and constant volume gas thermometers. Instrument characteristics and sample preparations for heat capacities and yields.

4070 (407) Vacuum Techniques. One credit. Prerequisite: PHYS 3610. Vacuum system design and construction with respect to pumps and their capabilities, gauges, and measurement of very low pressure, leak detection and leak repair, seals, and cements. Thin film deposition techniques in vacuum.

4310 (431) Electricity and Magnetism. Three credits. Prerequisite: PHYS 3160 or consent of instructor. 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 (433) Modern Optics. 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 (438) Introduction to Quantum Mechanics. Three credits. Prerequisites: PHYS 3110 and 3160 or permission of instructor. 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.

4630 (463) 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 (480A, 480B) 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 (480A) Special Topics A
4810 (480B) Special Topics B

4850-4860 (485A, 485B) 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 (490) Physics Senior Thesis. Two credits. Prerequisite: PHYS 4850 or consent of thesis advisor. 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.

4950 (495) Modern Physics Laboratory. One credit. Prerequisites: PHYS 2021 or 2121 and 3110. Concepts and ideas which formed the basis for an understanding of the atom and atomic phenomena. One three-hour laboratory.

Honors College

In addition to the above courses, the Department of Physics and Astronomy offers the following courses in Honors: PHYS 2011 (233H) and PHYS 2021 (234H). See current class schedule and Honors information in this catalog.