Undergraduate Handbook – 2016-2017 Catalog

This handbook is designed to serve as a guide for the Physics major. It contains information on the major, department, courses, and faculty.

Advisor Contact Points

The undergraduate advisor in physics is Dr. Wallace Glab.
To discuss a major, minor, or courses in physics contact him at the following:

Dr. Wallace Glab
Science 120A
(806) 834-1655

Wallace.glab@ttu.edu (email contact preferred)

Debra Boyce
Science 120B
(806) 834-6352

debra.boyce@ttu.edu

Physics Department office
Science 101
(806) 834-1655
fax (806) 742-1182
http://www.phys.ttu.edu/

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and **Texas Tech Society of Physics Students (SPS)**

Revised ~~04/20/2016~~ 07-21-2016

Texas Tech University
Department of Physics
Undergraduate Programs

Horn Professor: Estreicher; Bucy Professor: Wigmans; Professors: Akchurin, Duncan, Huang, Myles, and Owen; Associate Professors: Gibson, Glab, Grave de Peralta, Kaye, Kunori, Lamp, Lee, Maccarone, Sanati, Thacker, and Volobouev; Assistant Professors: Clark, Corsi, Sand.

This department supervises the Bachelor of Science, Master of Science, and Doctor of Philosophy degrees in physics. The department also supervises an applied physics option in the MS and PhD degrees.

The Bachelor of Science degree can be taken in any of three areas of concentration, to be described below. These concentrations allow a student to tailor his or her studies towards their particular career goals. Please refer to the sample course schedules below for details about each concentration. A physics major should declare to the department which concentration they choose by the beginning of their junior year (typically after having completed Physics III).

Majors in this department are required to maintain a minimum grade point average of 2.5 in physics courses and required MATH adjunct courses, and receive a C or better in each of these courses. Students also have a variety of University and College of Arts & Sciences requirements that must be met. The minimum number of hours to attain a degree in physics in each of the various concentrations is 120. Credit for any transferred physics hours will be handled on an individual basis with the department's undergraduate advisor. **Students transferring into Physics from another department** or college must have and maintain an overall grade point average of 2.5 or better to enter and remain in the program.

Students are strongly encouraged to devote time to undergraduate research. Research areas in the department include astrophysics, biophysics, condensed matter physics (including nanotechnology), nuclear physics, physics education, and particle physics.

The Physics B.S. curricula are designed around the assumption that physics students will minor in mathematics. However, a variety of other minors that complement study in physics can be selected. Choice of a minor other than mathematics may require that a student complete more than 120 hours for their degree.

B.S. in Physics, professional concentration: A traditional curriculum for a Physics major, intended to prepare the student for going on to graduate study or for seeking employment in the private or government sectors as a physicist. A typical sequence of courses begins with PHYS 1408, 2401, 2402, and 2305 for a total of 15 hours at the introductory level. These are usually followed by the intermediate and advanced sequences, PHYS 3304, 3305, 3306, 3401, 4302, 4304, 4307, and 4308. Two 3 hour Physics elective courses are also required. Students desiring to pursue advanced degrees are recommended to take advanced topic courses. Students are strongly encouraged to devote time to undergraduate research, and sign up for 3 hours of PHYS 3000 while they are doing it. This can count as a PHYS elective.

The required mathematics courses for physics majors are MATH 1451, 1452, 2450, PHYS 4325, and PHYS 4326 (Math Methods for Physics I and II). MATH 3354 and 4354 or 3350 and 3351 may be substituted for the Math Methods courses with the consent of the advisor for dual major students. Please note that the sequence under PHYS will count towards your math minor. Students

planning to pursue an advanced degree in physics should consult the physics undergraduate advisor about appropriate additional courses. Taking Math 2360 (Linear Algebra) is strongly encouraged.

B.S. in Physics, Astrophysics concentration: A variation of the professional concentration for students who have particular interest in astronomy and astrophysics intended to prepare students who, in addition to the possible employment paths associated with the professional concentration, may want to pursue graduate study in astronomy or astrophysics. This concentration has the same mathematics requirements as the professional option, very similar physics course requirements with one 2 hour free elective (PHYS 3306 is strongly recommended), and also includes 14 hours of ASTR courses. Majors in this concentration are strongly encouraged to minor in mathematics. Choice of a different minor will result in a student needing to take more than 120 hours to complete their degree. Students are strongly encouraged to devote time to undergraduate research.

B.S. in Physics, Applied Physics concentration: A variation of the professional concentration for students who wish to pursue more applied work, such as graduate study or employment in engineering or other technical fields. It requires the same coursework as the professional option (with only one PHYS elective and no requirement to take PHYS 4308), with an addition 12 required hours in an applied specialty or specialties. Applied electives must be approved by the Physics undergraduate advisor. Again, majors in this concentration are strongly encouraged to minor in mathematics. Choice of a different minor will result in a student needing to take more than 120 hours to complete their degree. Students are strongly encouraged to devote time to undergraduate research.

Minors for Physics majors: A broad variety of minor subjects may be chosen by a student majoring in physics. These include mathematics, biochemistry, physical chemistry, geophysics, computer science, business, and electrical engineering. A frequent minor choice for Physics majors is mathematics, the requirements for which are automatically satisfied by the sequence of MATH courses required for a Physics major (plus Linear Algebra). Students contemplating minors outside of the College of Arts & Sciences should seek the advice of the physics undergraduate advisor before beginning that minor.

Minor in Physics: A minor in physics by majors outside of physics requires 18 semester hours of which at least 6 must be at the 3000 level or higher and must be approved by the undergraduate advisor. The minor sequence is PHYS 1408, 2401, and 2402 plus 6 hours of approved 3000/4000 level courses. Students must receive a grade of C or better in all courses applied toward a minor. The astronomy courses (ASTR 1400 and 1401) may not be used to satisfy requirements for the physics major or minor (with the exception of 1401 for Astrophysics majors)

Minor in Astronomy: A minor in Astronomy by students majoring in subjects other than Physics Requires 21 semester hours of physics and astronomy courses, at least 9 of which must be at the 3000 or higher level and which must be approved by the undergraduate advisor. The recommended sequence is PHYS 1408, PHYS 2401, PHYS 2402, with additional credits selected from among ASTR 2401, ASTR 4301, ASTR 4302; PHYS 3302; and undergraduate research in astronomy (PHYS 3000). It should be noted that the first three courses have Calculus I, II, and III as pre-requisites. Under some circumstances, courses in engineering, geosciences or mathematics with significant astronomy content may be taken in place of the courses listed here.

Students are strongly encouraged to participate in the Society of Physics Students, which sponsors several academic and social activities. They are headquartered in Room 04 of the Science building. They provide free tutoring for members and organize many fun and/or educational events and trips.

Physics Major
Degree Requirements

I. General Education

English (12 hours) ENGL 1301 ENGL 1302 ENGL 23-- ENGL 23--

Oral Communication (3 hours) COMS (see catalog as there are several options)

Foreign Language: Freshman proficiency and 6 hours of a sophomore sequence for that language

Math (8 hours) MATH 1451 MATH 1452

Science (8 hours) PHYS 1408 PHYS 2401

History (6 hours) HIST 2300 and HIST 2301 or HIST 2310

Political Science (6 hours) POLS 1301 POLS 2302

Social and Behavioral Sciences (3 hours)

Language, Philosophy, and Culture (3 hours)

Creative Arts (3 hours)

Multicultural (3 hours)

Personal Fitness and Wellness (2 hours)

This menu of courses is required by Tech for any student seeking an A&S degree. The basic pattern is defined by the state and SACS. Courses for the various categories can be found near page 40 of the Undergraduate Catalog.

IIa1. Physics Major: PHYS courses for the Professional concentration (37 hours)

PHYS 2305 Computation for the Physical Sciences
PHYS 1408 Principles I- Mechanics
PHYS 2401 Principles II- E&M
PHYS 2402 Principles III- Modern
PHYS 3304 Intermediate Experimental Physics (Writing Intensive)
PHYS 3305 E&M I
PHYS 3306 E&M II
PHYS 3401 Optics (Writing Intensive)
PHYS 4302 Statistical
PHYS 4304 Mechanics
PHYS 4307 Quantum Mechanics
PHYS 4308 Quantum Mechanics II

Choose 6 or more hours

PHYS 3000 Undergraduate Research
PHYS 3302 Cosmophysics
PHYS 4000 Independent Study
PHYS 4301 Computational
PHYS 4306 Senior Project (Writing Intensive)
PHYS 4309 Solid State
PHYS 4312 Nuclear and Particle
ASTR 4301 Astrophysics I
ASTR 4302 Astrophysics II

12 hours of free electives

IIa2. Math

MATH 1451 Calculus I
MATH 1452 Calculus II
MATH 2450 Calculus III
PHYS 4325 Higher Math for Physicists (counts towards MATH minor)
PHYS 4326 Higher Math for Physicists (counts towards MATH minor)

Students are strongly encouraged to take MATH 2360, Linear Algebra

Students in the Professional concentration are assumed to minor in mathematics. Another choice of minor may result in requiring additional course hours beyond 120. Students must have at least 40 hours of Junior/Senior level courses.

IIb. Physics Major: PHYS and ASTR courses for the Astrophysics concentration (37 hours)

PHYS 2305 Computation for the Physical Sciences
PHYS 1408 Principles I- Mechanics
PHYS 2401 Principles II- E&M
PHYS 2402 Principles III- Modern
PHYS 3302 Cosmophysics
PHYS 3304 Intermediate Experimental Physics (Writing Intensive)
PHYS 3305 E&M I
PHYS 3401 Optics **or** PHYS 3306 E&M II (Optics is a Writing Intensive course and should be taken unless a student wants to do a Senior Project (4306). taking E&M II also is encouraged
PHYS 4302 Statistical
PHYS 4304 Mechanics
PHYS 4307 Quantum Mechanics
PHYS 4312 Nuclear and Particle Physics

ASTR courses

ASTR 1401 Stellar Astronomy
ASTR 2401 Observational Astronomy
ASTR 4301 Astrophysics I
ASTR 4302 Astrophysics II

One free elective (2 hours)

MATH requirements are the same as for the Professional concentration.

Students in the Astrophysics concentration are assumed to minor in mathematics. Another choice of minor may result in requiring additional course hours beyond 120. Students must have at least 40 hours of Junior/Senior level courses.

IIc. Course requirements for the Applied Physics concentration

PHYS requirements are the same as for the Professional concentration, without PHYS 4308. MATH requirements are also the same as for the Professional concentration. This concentration requires one PHYS elective and 1 free elective. This concentration also requires an additional 12 hours minimum of courses that constitute applied physics or engineering courses. These courses must be approved by the departmental advisor.

Pre-approved ECE courses: ECE 3302, 3303, 3311, 3312, 4314, 4341, 4344, 4353, 4354, 4381
Pre-approved Geophysics courses: GPH 2333, 3310, 4300, 4321, 4323
Pre-approved Wind Energy courses: WE 1300, 1310, 3300, 3301, 4322, 4321

Students in the Applied Physics concentration are assumed to minor in mathematics. Another choice of minor may result in requiring additional course hours beyond 120. Students must have at least 40 hours of Junior/Senior level courses.

Scheduling of Physics Course Offerings

The following courses are offered every long semester and summer session: ASTR 1400, ASTR 1401, PHYS 1408, and PHYS 2401. PHYS 2402, 3000, 4000, and 4306 are offered every long semester. PHYS 3000 may also be done in summer sessions.

Other courses are offered as shown in the listing below.

Odd Falls

2305 Computation for the Physical Sciences

3305 E&M I

3401 Optics

4307 Quantum I

4309 Solid State

ASTR 4302, Astrophysics II

ASTR 2401, Observational Astronomy

PHYS 4325 and 4326

Even Springs

3302 Cosmological Physics

3306 E&M II

3304 Intermediate Experimental Physics

4301 Computational

4302 Statistical

4304 Mechanics

4308 Quantum II

PHYS 4325 and 4326

ASTR 4301, Astrophysics I

Even Falls

2305 Computation for the Physical Sciences

3305 E&M I

3401 Optics

4307 Quantum I

PHYS 4325 and 4326

ASTR 4302, Astrophysics II

ASTR 2401, Observational Astronomy

Odd Springs

3304 Intermediate Experimental Physics

3306 E&M II

4302 Statistical

4304 Mechanics

PHYS 4325 and 4326

ASTR 4301, Astrophysics I

4308 Quantum II

4312 Nuclear and Particle

Physics Department Course Descriptions

1171. Physics Fieldwork (1:0:3). Interaction with public school teachers and students in delivering a limited lesson for students. Tech student will learn and implement a lesson. Intended for students who may be interested in the Secondary Education concentration.

1304. Physics: Basic Ideas and Methods (3:3:0). Intended to provide physics background to pre-engineering students. Examines basic concepts in physics. Problem-solving techniques, graphical representations, and pertinent mathematics. [PHYS 1310]

1401. Physics for Nonscience Majors (4:3:2). Course intended to acquaint students with the basic laws and vocabulary of physics. A minimum of mathematics is used.

1402. Physics of Living Matter (4:3:2). Covers the physics principles found in living matter and techniques useful in biomedical sciences. Not for physics majors.

1403, 1404. General Physics (4:3:3 each). Prerequisite: MATH 1320 and 1321. A non-calculus introductory physics course designed to provide students with a background for further study in science and related areas. Covers mechanics, heat, sound, electricity and magnetism, light, and modern physics.

1406. Physics of Sound and Music (4:3:3). A qualitative course designed to acquaint the student with the principles of physics used in the production of sound and music. A minimum of mathematics will be used. Some of the physical principles are exemplified in laboratory sessions. Satisfies natural science requirement in Arts and Sciences.

1408. Principles of Physics I (4:3:3). Prerequisite: MATH 1451. Calculus-based introductory physics course. Mechanics, kinematics, energy, momentum, gravitation, waves, and thermodynamics. (Honors section offered.)

2305. Computation for the Physical Sciences (3:3:0). Prerequisite: PHYS 1408 and 2401. Introduces computational tools to solve science problems. Emphasizes interplay between technology application and practical learning

2401. Principles of Physics II (4:3:3). Corequisite: MATH 1452. Calculus-based introductory physics. Electric and magnetic fields, electromagnetic waves, and optics. (Honors section offered.)

2402. Principles of Physics III (4:3:3). Prerequisite: PHYS 2401. Study of atomic, molecular, and nuclear phenomena. Relativity, quantum effects, hydrogen atom, many electron atoms, and some molecular physics. Includes laboratory.

3000. Undergraduate Research (V1-6). Individual and/or group research projects in basic or applied physics, under the guidance of a faculty member.

3302. Cosmophysics: the universe as a physics lab (3:3:0). Prerequisite: PHYS 2402. This course deals with topics from astrophysics, cosmology, and cosmic ray physics of interest to all physicists.

3304. Intermediate experimental physics (3:0:6). Corequisite: PHYS 2402. Laboratory course on advanced physical principles, including experiments in optics, atomic, molecular, solid state, and nuclear physics (writing intensive).

3305. Electricity and Magnetism I (3:3:0). Prerequisite: PHYS 2401 and MATH 4325 or equivalent. Electrostatics, dielectric material, Maxwell's equations, currents, and magnetostatics.

3306. Electricity and Magnetism II (3:3:0). Prerequisites: PHYS 3305. Magnetic properties of material, electrodynamics, electromagnetic waves, waveguides and resonators, interaction with matter, AC circuits, radiation.

3400. Fundamentals of Physics (4:3:3). Prerequisite: MATH 1320. Development of basic concepts of physics: Astronomy, motion, density, sound, electricity, magnetism, atoms, light, and radioactivity. Not for engineering, science, or mathematics majors.

3401. Optics (4:2:4). Prerequisite: PHYS 2401. Geometrical and physical optics with emphasis on the latter. Waves, reflection, scattering, polarization, interference, diffraction, modern optics, and optical instrumentation (writing intensive).

4000. Independent Study (V1-4). Prerequisite: Approval of advisor. Study of advanced topics of current interest under direct supervision of a faculty member.

4301. Computational Physics (3:2:2). Prerequisite: PHYS 1408, 2401, 2402. Numerical modeling of physical systems. Data acquisition and analysis. Graphics for displaying complex results. Quadrature schemes, solution of equations. Use of microcomputers in assignments.

4302. Statistical and Thermal Physics (3:3:0). Prerequisite: PHYS 2402 and knowledge of differential equations. Introduction to statistical methods in physics. Formulation of thermodynamics and statistical mechanics from a unified viewpoint with applications from classical and quantum physics.

4304. Mechanics (3:3:0). Prerequisite: PHYS 1408, 2401, or equivalent, and differential equations. Dynamics of particles and extended bodies, both rigid and fluid, using Newtonian mechanics and the Euler-Lagrange equations from Hamilton's principle. Nonlinear systems and chaos with numerical modeling. Applications of the Navier-Stokes equation.

4306. Senior Project (3). Prerequisite: Senior standing in physics or engineering physics. Individual research project under the guidance of a faculty member (writing intensive).

4307. Introduction to Quantum Mechanics (3:3:0). Prerequisite: PHYS 4325 or equivalent. Experimental and conceptual bases. Dualism, uncertainty principle. Mathematical framework. Schrödinger equation, solutions. Hydrogen atom. Pauli principle, spin. Periodic table. Perturbation theory.

4308. Quantum Mechanics II (3:3:0). Prerequisite: PHYS 4307. Review of quantum mechanics, time-independent and dependent perturbation theory, variational principle, WKB approximation, the adiabatic approximation and scattering.

4309. Solid State Physics (3:3:0). Prerequisite: PHYS 3305 and knowledge of elementary quantum mechanics. The structural, thermal, electric, and magnetic properties of crystalline solids. Free electron theory of metals. Concept of energy bands and elementary semiconductor physics.

4312. Nuclear and Particle Physics (3:3:0). Prerequisite: PHYS 4307. This is a course dealing with modern nuclear physics covering such topics as nuclear structure models, radioactivity, nuclear reactions, elementary particles, nuclear conservation, forces, and symmetry.

4325. Math Methods I (3:3:0) Prerequisites: MATH 2350 and 2360. Higher mathematical topics for physicists, including differential equations, complex analysis, matrix and tensor formalisms, and special functions.

4326. Math Methods II (3:3:0) Continuation of PHYS 4325.

4371. Physics as it is taught (3:2:3). Discusses the teaching of introductory material. Extends topic coverage into advanced treatments and mathematics. Designed for students seeking teaching certification.

4372. Astronomy as it is Taught (3:3:0). Discusses solar system, stellar, and galactic astronomy and develops the use of activities in the process of instruction. Designed for students seeking teaching certification.

4373. Math Modeling in Physics (3:3:0). Motivates the extensive use of mathematics in the practice of physics and teaching physics. Designed for students seeking teaching certification.

Astronomy Courses

ASTR 1400. Solar System Astronomy (4:3:2). Structure of the solar system. Gravitation, light, and orbits of the solar system. Planets and their moons, asteroids, and comets. (Honors section offered.)

ASTR 1401. Stellar Astronomy (4:3:2). Structure, models of the universe. Stellar evolution. Gravitation, light, orbits of the stars and galaxies. Endpoints of stellar evolution. (Honors section offered.)

ASTR 2401. Observational Astronomy (4:2:2). Prerequisite: ASTR 1400 or 1401 or consent of instructor. Designed for anyone interested in learning the use of an optical telescope, both visually and for imaging.

ASTR 4301. Astrophysics I (3:3:0). Prerequisite: PHYS 2402. Introduction to the tools of Astronomy, stellar properties, stellar structure, and stellar evolution.

ASTR 4302. Astrophysics II (3:3:0). Prerequisite: PHYS 2402. Planets and planetary systems, types and evolution of galaxies, cosmology, and the early universe.

Faculty Members

Nural Akchurin – Prof. 2000, Ph.D. Iowa 1990. Particle Physics.

Maurice Clark - Assistant Professor 2010. Astronomy.

Alessandra Corsi, Assistant Professor 2014, Ph.D. 2007, University of Rome I (La Sapienza). Astrophysics

Stefan Estreicher – Horn Prof. 1986, Ph.D. Zurich 1982. Solid state.

Tom Gibson – Associate Prof. 1985, Ph.D. Oklahoma 1982. Computer Center Director. AMO theory.

Wallace Glab – Associate Prof. 1990, Ph.D. Illinois 1984. Director of Undergraduate Programs.

Luis Grava de Peralta – Associate Prof. 2007, Ph.D. TTU 2000. Solid state.

Juyang Huang – Prof. 1999, Ph.D. Buffalo 1987. Biophysics.

Tony Kaye – Associate Prof. 2013, Ph.D. Georgia State 1998. Nano-tech and astrophysics.

Shuichi Kunori – Associate Professor 2013, Tohaka, Japan 1981. Particle Physics

David Lamp – Associate Prof. 1988, Ph.D. Missouri 1984. Physics education.

Benjamin J. Owen, Professor 2015, Ph.D., 1998, California Institute of Technology. Astrophysics

Sungwon Lee - Associate Prof. 2006, Ph.D. Glasgow 2000. Particle Physics.

Roger Lichti – Prof. 1979, Ph.D. Illinois 1972. Solid state.

Thomas Maccarone – Associate Prof. 2013, Ph.D. Yale 2001. Astrophysics.

Charles Myles – Prof. 1978, Ph.D. Washington 1973. Solid state.

Mahdi Sanati – Associate Prof. 2004, Ph.D. Cincinnati 1999. Solid state.

David Sand – Assistant Prof. 2013. Ph.D. Caltech 2005. Astrophysics.

Beth Ann Thacker – Associate Prof. 1999, Ph.D. Cornell 1990. Particles/Education.

Igor Volobouev – Associate Prof. 2006, Ph.D. SMU 1997. Particle Physics.

Richard Wigmans – Bucy Prof. 1992, Ph.D. Vrije, Amsterdam 1975. Particle Physics.