Texas Tech University
Department of Physics and Astronomy

Undergraduate Handbook

This handbook is designed to serve as a guide for the physics major. Only students who enter the College of Arts & Sciences in Fall 2025 or later will be under the guidelines of this booklet.

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Physics Major

B.S. Degree Requirements

General Education Requirements for the College of Arts & Sciences

English (9 hours) ENGL 1301 ENGL 1302 ENGL 23--

Oral Communication (3 hours)

Mathematics (6 hours) MATH 1451 MATH 1452

Life and Physical Sciences (8 hours) PHYS 1408 PHYS 2401

United States History (choose 6 hours) HIST 2300 HIST 2301 HIST 2310

Political Science (6 hours) POLS 1301 POLS 2306

Social and Behavioral Sciences (3 hours)

Language, Philosophy, and Culture (3 hours)

Creative Arts (3 hours)

Personal Fitness and Wellness (1 hour)

Foreign Language: Freshman proficiency plus 3 hours at the sophomore level or higher in the same language. (Students who wish to take Spanish should take the Spanish Placement Exam.)

40 Credits Required at the Junior/Senior Level

120 Credits Required Total

This menu of courses is required by Texas Tech University for any student seeking a B.S. degree in the College of Arts & Sciences. The basic pattern is defined by the state and SACS. Courses for the various categories can be found under "Academic Requirements" in the 2025-2026 Catalog or at https://www.depts.ttu.edu/artsandsciences/CurrentStudents/gen_degree_req.php

***Communication Literacy Requirement:** Regardless of concentration, a physics major must take at least 3 courses with the Communication Literacy (CL) attribute within the major. Communication Literacy (CL) courses (marked with an asterisk below) will be aimed towards providing and assessing student abilities in both oral and written communication of scientific information in the specific ways that are common to professional physicists and astrophysicists, both in traditional and non-traditional positions.

Physics Major: Professional Concentration

Physics Core Curriculum (35 hours)

PHYS 1408 Principles I: Mechanics
PHYS 2401 Principles II: E&M
PHYS 2305 Computation for the Physical Sciences*
PHYS 3201 Modern Physics Lab and Data Analysis (must be taken with 3301)
PHYS 3301 Modern Physics
PHYS 3304 Intermediate Experimental Physics*
PHYS 3305 Electricity & Magnetism I
PHYS 3401 Optics*
PHYS 4302 Statistical & Thermal
PHYS 4304 Mechanics
PHYS 4307 Quantum Mechanics I
PHYS 4308 Quantum Mechanics II

Required Professional Physics Courses (9 hours)

PHYS 3306 Electricity & Magnetism II
PHYS 4306 Capstone Project*
PHYS 4308 Quantum Mechanics II

Physics Electives (choose 6 hours)

PHYS 3000 Undergraduate Research
PHYS 4000 Independent Study
PHYS 4301 Computational
PHYS 4309 Solid State
PHYS 4312 Nuclear & Particle
PHYS 4315 Intro to Quantum Computing
PHYS 4350 Relativity
ASTR 3300 Special Topics in Astrophysics
ASTR 4301 Astrophysics I
ASTR 4302 Astrophysics II
ASTR 4305 Radiative Processes

Required Mathematics Courses (18 hours)

MATH 1451 Calculus I
MATH 1452 Calculus II
MATH 2450 Calculus III
PHYS 4325 Math Methods for Physicists I (or MATH 4325 or MATH 3350 or MATH 3354)
PHYS 4326 Math Methods for Physicists II (or MATH 4326 or MATH 3351 or MATH 4354)

Students are strongly encouraged to take MATH 2360 (Linear Algebra) to complete a MATH minor.

Physics Major: Astrophysics Concentration

Physics Core Curriculum (35 hours)

PHYS 1408 Principles or Physics I: Mechanics
PHYS 2401 Principles or Physics II: E&M
PHYS 2305 Computation for the Physical Sciences*
PHYS 3201 Modern Physics Lab and Data Analysis (must be taken with 3301)
PHYS 3301 Modern Physics
PHYS 3304 Intermediate Experimental Physics *
PHYS 3305 Electricity & Magnetism I
PHYS 3401 Optics*
PHYS 4302 Statistical & Thermal
PHYS 4304 Mechanics
PHYS 4307 Quantum Mechanics I

Required Astronomy and Astrophysics Courses (14 hours)

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

Astrophysics Electives (choose 9 hours)

PHYS 3000 Undergraduate Research (maximum 3 hours—astronomy or astrophysics topic)
PHYS 4312 Nuclear & Particle
PHYS 4350 Relativity
ASTR 3300 Special Topics in Astrophysics
ASTR 4305 Radiative Processes

Required Mathematics Courses (18 hours)

MATH 1451 Calculus I
MATH 1452 Calculus II
MATH 2450 Calculus III
PHYS 4325 Math Methods for Physicists I (or MATH 4325 or MATH 3350 or MATH 3354)
PHYS 4326 Math Methods for Physicists II (or MATH 4326 or MATH 3351 or MATH 4354)

Students are strongly encouraged to take MATH 2360 (Linear Algebra) to complete a MATH minor.

Physics Major: Quantum Science and Technology Concentration

Physics Core Curriculum (35 hours)

PHYS 1408 Principles of Physics I: Mechanics
PHYS 2401 Principles of Physics II: E&M
PHYS 2305 Computation for the Physical Sciences*
PHYS 3201 Modern Physics Lab and Data Analysis (must be taken with 3301)
PHYS 3301 Modern Physics
PHYS 3304 Intermediate Experimental Physics *
PHYS 3305 Electricity & Magnetism I
PHYS 3401 Optics*
PHYS 4302 Statistical & Thermal
PHYS 4304 Mechanics
PHYS 4307 Quantum Mechanics I

Required Quantum Science & Technology Courses (6 hours)

MATH 2360 Linear Algebra
PHYS 4315 Introduction to Quantum Computing

Quantum Science & Technology Electives (choose 9 hours)

PHYS 3000 Undergraduate Research (maximum 3 hours—quantum science-related topic)
PHYS 3306 Electricity & Magnetism II
PHYS 4308 Quantum Mechanics II
PHYS 4309 Solid State Physics
ECE 4370 Machine Learning

Required Mathematics Courses (18 hours)

MATH 1451 Calculus I
MATH 1452 Calculus II
MATH 2450 Calculus III
PHYS 4325 Math Methods for Physicists I (or MATH 4325 or MATH 3350 or MATH 3354)
PHYS 4326 Math Methods for Physicists II (or MATH 4326 or MATH 3351 or MATH 4354)

Students are strongly encouraged to declare a MATH minor, as all courses required for the minor will be completed within this concentration.

Course Planning for a Calculus-Ready Physics Major

The following is an example of how the four years of a calculus-ready Texas Tech physics major might be structured. Courses outside the Physics & Astronomy department and electives for the professional and quantum science and technology concentrations have been omitted. This table is just an example—always confer with the academic advisor before registering for classes.

FIRST YEAR	
Fall	**Spring**
MATH 1451 Calculus I	PHYS 1408 Physics I
*ASTR 1401 Stellar Astronomy	MATH 1452 Calculus II
SECOND YEAR	
Fall	**Spring**
PHYS 2401 Physics II	PHYS 2305 Computation
^***MATH 2360 Linear Algebra	PHYS 3201 Modern Lab & Data Analysis
MATH 2450 Calculus III	PHYS 3301 Modern Physics
*ASTR 2401 Observational Astronomy	PHYS 4325 Math Methods I
THIRD YEAR	
Fall	**Spring**
PHYS 3305 E&M I	**PHYS 3306 E&M II
PHYS 3401 Optics	PHYS 4304 Mechanics
PHYS 4326 Math Methods II	*ASTR 3300 Special Topics
***PHYS 4315 Into to Quantum Computing	*ASTR 4301 Astrophysics I
FOURTH YEAR	
Fall	**Spring**
PHYS 4307 Quantum Mechanics I	PHYS 3304 Intermediate Lab
*ASTR 4302 Astrophysics II	PHYS 4302 Statistical & Thermal Physics
*ASTR 4305 Radiative Processes	**PHYS 4306 Capstone Project
	**PHYS 4308 Quantum Mechanics II
	*PHYS 4312 Nuclear & Particle **–OR–** PHYS 4350 Relativity

^ Required for the mathematics minor
*Required for the astrophysics concentration
**Required for the professional concentration
***Required for the quantum science and technology concentration

Scheduling of Physics Course Offerings

The courses PHYS 1408 and 2401 are offered every long semester and summer session. The ASTR courses 1400 and 1401 and the PHYS courses 2302 and 3301 + 3201 are offered every long semester. PHYS 3000, 4000, and 4306 may be taken during any semester or summer session with instructor permission. Other courses are offered as shown in the listing below and ***depending on instructor availability.***

Courses Offered in AY 2025-2026	
FALL 2025	**SPRING 2026**
3305 E&M I	2305 Computation for the Physical Sciences
3401 Optics	3304 Intermediate Physics Laboratory
4307 Quantum I	3306 E&M II
4309 Solid State	4301 Computational
4315 Intro to Quantum Computing	4302 Statistical & Thermal
4326 Math Methods II	4304 Mechanics
ASTR 2401 Observational Astronomy	4308 Quantum II
ASTR 4302 Astrophysics II	4312 Nuclear & Particle
ASTR 4305 Radiative Processes	4325 Math Methods I
	ASTR 3300 Special Topics
	ASTR 4301 Astrophysics I

Courses Tentatively Planned for Future Semesters	
EVEN FALLS	**ODD SPRINGS**
3305 E&M I	2305 Computation for the Physical Sciences
3401 Optics	3304 Intermediate Physics Laboratory
4307 Quantum I	3306 E&M II
4309 Solid State	4301 Computational
4315 Intro to Quantum Computing	4302 Statistical & Thermal
4326 Math Methods II	4304 Mechanics
ASTR 2401 Observational Astronomy	4308 Quantum II
ASTR 4302 Astrophysics II	4312 Nuclear & Particle
ASTR 4305 Radiative Processes	4325 Math Methods I
	4312 Nuclear & Particle
	ASTR 3300 Special Topics
	ASTR 4301 Astrophysics I
ODD FALLS	**EVEN SPRINGS**
3305 E&M I	2305 Computation for the Physical Sciences
3401 Optics	3304 Intermediate Physics Laboratory
4307 Quantum I	3306 E&M II
4315 Intro to Quantum Computing	4301 Computational
4326 Math Methods II	4302 Statistical & Thermal
ASTR 2401 Observational Astronomy	4304 Mechanics
ASTR 4302 Astrophysics II	4308 Quantum II
ASTR 4305 Radiative Processes	4350 Relativity
	4325 Math Methods I
	ASTR 3300 Special Topics
	ASTR 4301 Astrophysics I

Physics Course Descriptions

PHYS 1408. Principles of Physics I (4:3:2). 4 Credit Hours. Prerequisite: MATH 1451. Calculus-based introductory physics covering mechanics, kinematics, energy, momentum, and thermodynamics. (Honors section offered) Partially fulfills core Life and Physical Sciences requirement.

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

PHYS 2401. Principles of Physics II (4:3:2). 4 Credit Hours. Prerequisites: PHYS 1408 and MATH 1452. Calculus-based introductory physics covering electric and magnetic fields, electromagnetic waves, and optics. (Honors section offered) Partially fulfills core Life and Physical Sciences requirement.

PHYS 3000. Undergraduate Research (V1-6). 1 to 6 Credit Hours. Prerequisite: Permission of the instructor. Individual and/or group research projects in basic or applied physics, under the guidance of a faculty member.

PHYS 3201. Modern Physics Lab and Data Analysis (2:1:3). 2 Credit Hours. Corequisite PHYS 3301. Laboratory experiments and accompanying lectures designed to illustrate the basis of quantum physics and proper techniques for data acquisition, analysis, and determination of uncertainties.

PHYS 3301. Modern Physics (3:3:0). 3 Credit Hours. Prerequisite: PHYS 1408 and MATH 2450. Corequisites: PHYS 3201 or PHYS 3101. Failure of classical physics in the microscopic realm, development and fundamentals of quantum theory, applications to atoms, molecules, solids, nuclei, and particles.

PHYS 3304. Intermediate Physics Laboratory (3:0:6). 3 Credit Hours. Prerequisite: C or better in PHYS 3301 and PHYS 2305. Laboratory course on advanced physical principles. Experiments in atomic, molecular, solid state, and nuclear, and particle physics as well as relativity, electricity and magnetism including data acquisition and analyses. (Communication Literacy).

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

PHYS 3306. Electricity and Magnetism II (3:3:0). 3 Credit Hours. Prerequisite: PHYS 3305 and MATH 4326 or equivalent. Magnetic properties of materials, electrodynamics, electromagnetic waves, waveguides and resonators, interaction with matter, AC circuits, radiation.

PHYS 3401. Optics (4:2:4). 4 Credit Hours. Prerequisites: PHYS 3301. Covers geometrical and physical optics, waves, reflection, scattering, polarization, interference, diffraction, modern optics, and optical instrumentation. (Communication Literacy).

PHYS 4000. Independent Study (V1-4). 1 to 4 Credit Hours. Prerequisite: Approval of advisor. Study of advanced topics of current interest under direct supervision of a faculty member.

PHYS 4301. Computational Physics (3:3:0). 3 Credit Hours. Prerequisites: PHYS 1408, PHYS 2305, PHYS 2401, PHYS 3301. Numerical modeling of physical systems. Data acquisition and analysis. Graphics for displaying complex results. Quadrature schemes, solution of equations.

PHYS 4302. Statistical and Thermal Physics (3:3:0). 3 Credit Hours. Prerequisites: PHYS 3301 and PHYS 4325 or equivalent. Introduction to statistical methods in physics. Formulation of thermodynamics and statistical mechanics from a unified viewpoint with applications from classical and quantum physics.

PHYS 4304. Mechanics (3:3:0). 3 Credit Hours. Prerequisite: PHYS 1408 and PHYS 4325 or equivalent. 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.

PHYS 4306. Capstone Project (3). 3 Credit Hours. Prerequisite: Senior standing in physics major. Research in a current topic in physics and astronomy with a faculty mentor culminating in an oral presentation and a written report. (Communication Literacy).

PHYS 4307. Quantum Mechanics I (3:3:0). 3 Credit Hours. Prerequisite: C or better in PHYS 3301 and PHYS 4325 or equivalent. Introduction to fundamental concepts in quantum mechanics: probability, normalization, operators, solutions to Schrodinger equation for various potentials. Discussion of quantum mechanics in 3D, generalized uncertainty principle, angular momentum and hydrogen atom.

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

PHYS 4309. Solid State Physics (3:3:0). 3 Credit Hours. Prerequisites: 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.

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

PHYS 4315. Introduction to Quantum Computing (3:3:0). 3 Credit Hours. Prerequisite: Permission of instructor. Covers two-level quantum systems, qubits, quantum gates and circuits, measurement, entanglement, Bell's Theorem, no-cloning theorem, quantum parallelism, quantum teleportation, quantum algorithms.

PHYS 4325. Mathematical Methods in Physical Sciences I (3:3:0) 3 Credit Hours. Prerequisite: C or better in MATH 2450. Vectors and coordinate systems, vector and scalar fields, ordinary differential equations, boundary-value problems and partial differential equations. (MATH 4325)

PHYS 4326. Mathematical Methods in Physical Sciences II (3:3:0) 3 Credit Hours. Prerequisite: C or better in PHYS 4325. Continuation of PHYS 4325. Calculus of variations, an introduction to complex analysis special functions, integral transforms. (MATH 4326)

PHYS 4350. Relativity (3:3:0) 3 Credit Hours. Prerequisite: C- or better in PHYS 3305. Prerequisite or corequisite: PHYS 4304. Introduction to spacetime, differential geometry, special and general relativity; with applications to black holes, cosmology, and gravitational waves.

Astronomy Course Descriptions

ASTR 1400. Solar System Astronomy (4:3:2). 4 Credit Hours. Covers the sun, planets, moons, asteroids, comets, gravitation, and formation. (Honors section offered.) Partially fulfills core Life and Physical Sciences requirement.

ASTR 1401. Stellar Astronomy (4:3:2). 4 Credit Hours. Covers stars, star formation, galaxies, and cosmology models. (Honors section offered.) Partially fulfills core Life and Physical Sciences requirement.

ASTR 2401. Observational Astronomy (4:3:2). 4 Credit Hours. 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 3300. Special Topics in Astrophysics (3:3:0). 3 Credit Hours. Prerequisites: C- or better in ASTR 2401, PHYS 2302, PHYS 3301, and PHYS 4325 or equivalent. (*Some prerequisites may be waived on a case by case basis with instructor permission*.) Topics in radio astronomy, X-ray astronomy, gravitational wave astronomy, compact objects, accretion, stellar explosions and others. May be repeated in different areas.

ASTR 4301. Astrophysics I (3:3:0). 3 Credit Hours. Prerequisite: PHYS 3301. Introduction to the tools of astronomy, stellar properties, stellar structure, and stellar evolution.

ASTR 4302. Astrophysics II (3:3:0). 3 Credit Hours. Prerequisite: PHYS 3301. Structure, formation and evolution of galaxies; cosmology.

ASTR 4305. Radiative Processes in Astrophysics (3:3:0). 3 Credit Hours. Prerequisite: C- or better in PHYS 3305. Prerequisite or corequisite: PHYS 4307. A survey of the physical processes related to the production and propagation of radiation in astrophysical phenomena, including thermal and non-thermal radiation, and atomic transitions.

Faculty Members

Nural Akchurin – Prof. 2000. Ph.D. 1990, U Iowa. High Energy Physics.

Vallia Antoniou – Assistant Prof. of Practice. 2019. Ph.D. 2008, U Crete. Preston Gott Observatory Dir. Astrophysics.

Elias Aydi – Assistant Prof. 2024. Ph.D. 2018, U Cape Town. Astrophysics.

Dmitry Bolmatov – Assistant Prof. 2025. Ph.D. 2013, Queen Mary U. of London. Biophysics.

Ioannis Chatzakis – Assistant Prof. 2019. Ph.D. 2009, Kansas State U. Condensed Matter Physics.

Jordan Damgov – Lecturer 2022. Ph.D. 2010, INRNE Bulgarian Academy of Science.

Wade DeGottardi - Assistant Prof. 2020. Ph.D. 2012, U. Illinois Urbana-Champaign. Condensed Matter Physics.

Robert Duncan – Prof. 2014. Ph.D. 1988, UC Santa Barbara. Condensed Matter Physics.

Yun Suk Eo – Assistant Prof. 2023. Ph.D. 2017, U Michigan. Condensed Matter Physics.

Hira Farooq – Lecturer 2024. Ph.D. 2020, Texas Tech U.

Michael Fausnaugh – Assistant Prof. 2023. Ph.D. 2017, Ohio State U. Astrophysics.

Yongbin Feng – Assistant Prof. 2024. Ph.D. 2020, U Maryland. High Energy Physics.

Thomas Gibson – Associate Prof. 1985. Ph.D. 1982, U Oklahoma. Atomic, Molecular & Optical Physics.

Emilia Järvelä – Assistant Prof. 2024. D.Sc. 2018, Aalto U. Astrophysics.

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

Myoung-Hwan Kim – Assistant Prof. 2019. Ph.D. 2010, SUNY Buffalo. Condensed Matter Physics.

Sung-Won Lee – Prof. 2006. Ph.D. 2000, U Glasgow. Chair. High Energy Physics.

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

Christopher Madrid – Assistant Prof. 2024. Ph.D. 2020, Baylor U. High Energy Physics.

Nihan Pol – Assistant Prof. 2024. Ph.D. 2020, West Virginia U. Astrophysics.

Mahdi Sanati – Prof. 2004. Ph.D. 1999, U Cincinnati. Grad Recruiter. Condensed Matter Physics.

Beth Ann Thacker – Prof. 1999. Ph.D. 1990, Cornell U. Physics Education.

Hung-Ming Tsai – Lecturer 2021. Ph.D. 2011, Duke U.

Igor Volobouev – Associate Prof. 2006. Ph.D. 1997, Southern Methodist U. Graduate Advisor. High Energy Physics.