PHYSICS (PHYS)

PHYS 101 Conceptual Physics (Units: 3)
Prerequisite: Category I or II placement for QR/Math, or GE Area B4, or MATH 197.

Conceptual introduction to Newton's Laws of Motion, properties of matter and energy, heat, sound, light, electricity, magnetism, and atoms.
Course Attributes:

- B1: Physical Science

PHYS 102 Conceptual Physics Laboratory (Unit: 1)
Prerequisite: Concurrent enrollment in PHYS 101.

Laboratory exercises in basic physics.
Course Attributes:

- B3: Lab Science

PHYS 111 General Physics I (Units: 3)
Prerequisites: MATH 198 or MATH 199 or equivalent with a grade of C-minus or higher. Concurrent enrollment in PHYS 112 required. If pre-calculus was completed in high school, the online Math Preparation for Physics mini-course is required; see the Department of Physics & Astronomy website for details.

Introduction to mechanics, waves, sound, fluids, thermodynamics, with applications to biology, life, and health sciences.
Course Attributes:

- B1: Physical Science

PHYS 112 General Physics I Laboratory (Unit: 1)
Prerequisite: Concurrent enrollment in PHYS 111.

Mechanics, heat, and sound. Extra fee required.
Course Attributes:

- B3: Lab Science

PHYS 121 General Physics II (Units: 3)
Prerequisites: PHYS 111 with a grade of C- or better; concurrent enrollment in PHYS 122.

Introduction to electricity, magnetism, light, optics, atoms, and quantum mechanics, with applications to biology, life, and health sciences.

PHYS 122 General Physics II Laboratory (Unit: 1)
Prerequisite: Concurrent enrollment in PHYS 121.

Light, electricity, magnetism, atoms, and modern physics. Extra fee required.

PHYS 220 General Physics with Calculus I (Units: 3)
Prerequisites: MATH 226 with a grade of C or better; concurrent enrollment in PHYS 222; concurrent enrollment in MATH 227 recommended.

Introduction to classical mechanics, including vectors, kinematics in one & two dimensions, Newton's Laws of Motion, force & acceleration, linear momentum & impulse, work & kinetic energy, potential energy & conservation of energy, elastic & inelastic collisions, torque & angular momentum, static equilibrium, fixed-axis rotational dynamics, oscillatory motion, gravitation & planetary motion.
Course Attributes:

- B1: Physical Science

PHYS 222 General Physics with Calculus I Laboratory (Unit: 1)
Prerequisite: Concurrent enrollment in PHYS 220.

Experiments in mechanics. Extra fee required.
Course Attributes:

- B3: Lab Science

PHYS 230 General Physics with Calculus II (Units: 3)
Prerequisites: PHYS 220 and MATH 227 with grades of C or better; concurrent enrollment in PHYS 232; concurrent enrollment in MATH 228 recommended.

Introduction to electricity and magnetism, including electric charge and Coulomb's Law, electric field and Gauss's Law, electric potential and electrical potential energy, capacitance, current and resistance, DC circuits, magnetic force and magnetic field, Biot-Savart Law and Ampere's Law, electromagnetic induction and Faraday's Law, inductance, RLC circuits and AC circuits, electromagnetic waves, and Maxwell's equations.

PHYS 232 General Physics with Calculus II Laboratory (Unit: 1)
Prerequisite: Concurrent enrollment in PHYS 230.

Experiments in electricity and magnetism. Extra fee required.

PHYS 240 General Physics with Calculus III (Units: 3)
Prerequisites: PHYS 220 and MATH 227 with grades of C or better; concurrent enrollment in PHYS 242; concurrent enrollment in MATH 228 recommended.

Introduction to thermodynamics & kinetic theory, properties of solids, liquids & gasses, mechanical waves & sound, electromagnetic waves, geometric optics, interference & diffraction, wave-particle duality & quantum mechanics.

PHYS 242 General Physics with Calculus III Laboratory (Unit: 1)
Prerequisite: Concurrent enrollment in PHYS 240.

Experiments in wave motion, optics, and thermodynamics.

PHYS 320 Modern Physics I (Units: 3)
Prerequisites: MATH 228, PHYS 230, and PHYS 240 with grades of C or better; MATH 245 or MATH 376 with a grade of C or better (may be taken concurrently).

Introduction to special relativity and quantum mechanics, including blackbody radiation, photoelectric effect, Compton effect, Bohr model of the hydrogen atom, wave-particle duality, wavefunctions, Heisenberg uncertainty principle, Schrödinger equation, one-dimensional potentials.
PHYS 321 Modern Physics Laboratory (Units: 2)
Prerequisite: Concurrent enrollment in PHYS 320.
Experiments on quantum physics and other phenomena of modern physics. Methods of data and error analysis. Classwork, 1 unit; laboratory, 1 unit.

PHYS 325 Modern Physics II (Units: 3)
Prerequisite: PHYS 320 with a grade of C- or better.

PHYS 330 Analytical Mechanics I (Units: 3)
Prerequisites: PHYS 230, PHYS 240, and MATH 228; MATH 245 or MATH 376; all with grades of C or better.

PHYS 360 Electricity and Magnetism I (Units: 3)
Prerequisites: MATH 245 or MATH 376; PHYS 385; with grades of C- or better.

PHYS 370 Thermodynamics and Statistical Mechanics (Units: 3)
Prerequisite: PHYS 320 with a grade of C- or better.

PHYS 385 Introduction to Theoretical Physics I (Units: 3)
Prerequisites: PHYS 230, PHYS 240, and MATH 228 with grades of C or better; and MATH 245 or MATH 376 with a grade of C or better (may be taken concurrently).

PHYS 390 Quantum Mechanics I (Units: 3)
Prerequisites: PHYS 320 and PHYS 360 with grades of C- or better.

PHYS 400 Computational Physics (Units: 3)
Prerequisites: CSC 210 or CSC 309 or ENGR 213; MATH 245 or MATH 376; PHYS 320; all with grades of C or better.

PHYS 410 Introduction to Solid State Physics (Units: 3)
Prerequisites: PHYS 320 and PHYS 360 with grades of C- or better.

PHYS 420 Electricity and Magnetism II (Units: 3)
Prerequisite: PHYS 360 with a grade of C- or better.

PHYS 430 Quantum Mechanics II (Units: 3)
Prerequisite: PHYS 430 with a grade of C- or better.

PHYS 440 Introduction to Optics & Photonics (Units: 3)
Prerequisites: PHYS 320 and PHYS 360 with grades of C- or better.

PHYS 450 Introduction to Solid State Physics (Units: 3)
Prerequisites: PHYS 320 and PHYS 360 with grades of C- or better.

PHYS 460 Electricity and Magnetism II (Units: 3)
Prerequisite: PHYS 360 with a grade of C- or better.

PHYS 470 Thermodynamics and Statistical Mechanics (Units: 3)
Prerequisite: PHYS 320 with a grade of C- or better.

PHYS 480 Introduction to Optics & Photonics (Units: 3)
Prerequisites: PHYS 320 and PHYS 360 with grades of C- or better.

PHYS 490 Physics Project Laboratory (Units: 2)
Prerequisite: PHYS 321 with a grade of C- or better.

PHYS 491GW Advanced Laboratory II - GWAR (Unit: 1)
Prerequisites: GE Area A2; PHYS 490 with a grade of C or better.

Advanced laboratory work in atomic, nuclear, solid state, and optical physics. Preparation of publication-quality reports and oral presentations on experiments. (ABC/NC grading only)

Course Attributes:

- Graduation Writing Assessment
PHYS 495 Introduction to Apparatus Fabrication (Unit: 1)
Prerequisites: Physics majors; PHYS 490 with a grade of C- or better; permission of the instructor.

Laboratory work with materials, machine tools (lathe, mill, etc.), and fabrication methods for the production of experimental research apparatus. Safety considerations.

PHYS 685 Instructional Methods in Teaching Physics (Unit: 1)
Prerequisite: Upper-division standing.

Pedagogical strategies and principles of teaching and learning in STEM. Seminar for students in their first Learning Assistant (LA) or Supplemental Instruction (SI) position.

PHYS 686 Experiences in Teaching Physics (Unit: 1)
Prerequisite: Upper-division standing.

Activity practicum for students serving as Learning Assistants (LAs) in STEM courses. LAs will directly assist STEM instructors in facilitating active learning in their classrooms. May be repeated for a total of 6 units.

PHYS 695 Culminating Experience in Physics (Unit: 1)
Prerequisite: Final semester of a Physics degree program.

Preparation of a portfolio of work completed in classes required for the degree. The final examination will be the ETS physics major field test.

PHYS 697 Senior Project (Units: 1-3)
Prerequisite: PHYS 490; permission of the faculty adviser.

Participation in experimental or theoretical project under the direction of faculty member. Written report of specific observations and calculations required. May be repeated with permission of the advisor.

PHYS 699 Independent Study (Units: 1-3)
Prerequisite: Approval of department and permission of the instructor.

Study in the laboratory or library under the direction of a member of the department. For students majoring or minoring in physics. Student must present a detailed written report of the work accomplished to the department. May be repeated for a total of 12 units.

PHYS 701 Classical Mechanics (Units: 3)
Prerequisite: Graduate standing or permission of the instructor.

Lagrangian and Hamiltonian mechanics; motion in arbitrary central force potentials; canonical transformation theory; Liouville's theorem; computer visualizations of phase space trajectories and topologies; collisionless Boltzmann equation applied to stellar dynamics; Jeans theorems, orbital anisotropy, and phase space distribution functions.

PHYS 704 Electrodynamics (Units: 3)
Prerequisites: Graduate standing or permission of the instructor. PHYS 785 strongly recommended.

Boundary-value problems in electrostatics; multipoles, electrostatics of macroscopic media, dielectrics; magnetostatics, Faraday's Law, quasi-static fields; Maxwell equations, macroscopic electromagnetism, conservation laws; plane electromagnetic waves and wave propagation.

PHYS 706 Quantum Mechanics (Units: 3)
Prerequisites: Graduate standing or permission of the instructor. PHYS 785 strongly recommended.

Bound states, collision theory, matrix mechanics, symmetry and groups, perturbation theory.
PHYS 740 Computational Physics (Units: 3)
Prerequisites: CSC 210 or CSC 309 or ENGR 213; MATH 245 or MATH 376; PHYS 320; all with grades of C or better.

Analysis and development of numerical algorithms with a focus on computer simulations of physical systems. Topics may include: finite difference methods for nonlinear ordinary differential equations and chaos theory, N-body gravitational systems and molecular dynamics; numerical linear algebra; Fast Fourier Transforms, finite difference and spectral methods for partial differential equations; Monte Carlo methods for integration, Markov chains, statistical mechanics and spin systems; introduction to parallel programming. Lecture, 2 units; laboratory, 1 unit. (PHYS 740/PHYS 440 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

PHYS 775 Statistical Mechanics (Units: 3)
Prerequisite: Graduate standing or permission of the instructor.


PHYS 785 Theoretical Physics (Units: 3)
Prerequisite: Graduate standing or permission of the instructor.

Advanced concepts and techniques in mathematics applied to problems in physics. Applications in mechanics, electricity and magnetism, and fluids.

PHYS 832 Instructional Methods in Physics (Units: 2)
Prerequisites: Graduate standing or permission of the instructor; concurrent GTA appointment.

Instructional methods for the teaching of physics laboratories including the introductory lecture, laboratory safety procedures, supervision of laboratory students, proper handling of equipment and demonstrations, and best practices in maintaining lab logbooks and writing lab reports. May be repeated for a total of 4 units. (CR/NC grading only)

PHYS 855 Inclusive Pedagogy for the Physical Sciences (Units: 3)
Prerequisite: Graduate standing or permission of the instructor.

Development and refinement of effective, evidence-based, student-centered teaching strategies for the physical sciences with a special focus on inclusive practices to foster equity. Activities include discussion, reflection, peer observations, and projects.

PHYS 890 Introduction to Physics Research (Units: 1-3)
Prerequisite: Graduate standing.

Introduction to methods of physics research. May be repeated for a total of 5 units. (CR/NC only)

PHYS 891 Physics Research Design (Units: 1-3)
Prerequisites: Passed Level 1 Written English Proficiency Requirement and have research project approved.

Elements of Physics/Astronomy research proposals: literature review, project significance, and feasibility, materials and methods, budget, data analysis and presentation, statistical significance, reference notation. May be repeated for a total of 4 units.

PHYS 895 Culminating Project (Units: 3)
Prerequisites: Advancement to Candidacy (ATC) and Proposal for Culminating Experience (PCE) forms must be approved by the Division of Graduate Studies before registration.

Independent and original culminating project in physics under faculty supervision leading to written project report and oral defense of the project. Culminating projects could include: development of new teaching/curricular modules, portfolios of science writing/journalism, internships in science museums/planetaria or industrial or national research labs, development of technical reports/manuals for new scientific instruments, etc. (CR/NC, RP)

PHYS 896 Directed Reading in Physics (Units: 1-3)
Prerequisite: Graduate standing.

Readings/tutorials to achieve better understanding of specific topics based on individual student need. Focus on review and integration of core concepts in preparation for the comprehensive oral examination. (Does not count toward MS degree requirements.) (CR/NC only)

PHYS 896EXM Culminating Experience Examination (Unit: 0)
Prerequisites: Advancement to Candidacy (ATC) and Proposal for Culminating Experience (PCE) forms must be approved by the Division of Graduate Studies before registration.

Comprehensive oral examination on core topics in physics. (CR/NC, RP)

PHYS 897 Research (Units: 1-3)
Prerequisite: Completed undergraduate major in physics.

Independent and original laboratory investigation under supervision of a staff member. May be repeated. (Plus-minus letter grade, CR/NC, RP)

PHYS 898 Master's Thesis (Units: 3)
Prerequisites: Permission of the instructor and approval of Advancement to Candidacy (ATC) and Culminating Experience (CE) forms by Graduate Studies.

Advancement to Candidacy and Proposal for Culminating Experience Requirement forms must be approved by the Graduate Division before registration. (CR/NC, RP grading only)

PHYS 899 Culminating Experience Examination (Unit: 0)
Prerequisites: Approval of department and permission of the instructor.

Independent and original culminating project in physics under faculty supervision leading to written project report and oral defense of the project. Culminating projects could include: development of new teaching/curricular modules, portfolios of science writing/journalism, internships in science museums/planetaria or industrial or national research labs, development of technical reports/manuals for new scientific instruments, etc. (CR/NC, RP)

PHYS 899 Independent Study (Units: 1-3)
Prerequisite: Approval of department and permission of the instructor.

Study in the laboratory or library under the direction of a member of the department. For graduate students in physics. The student must present a detailed written report of the work accomplished to the department. May be repeated.