PHYSICS (PHYS)

PHYS 100 Fundamentals of Physics (3 credits)
General Education: Natural and Applied Sciences
Carries no credit after PHYS 111 or PHYS 211. For students in nontechnical fields. Conceptual study of laws of nature and their application, including mechanics, heat, electricity and magnetism, light, and modern physics. Three lectures per week. (Fall only)

PHYS 100L Fundamentals of Physics Lab (1 credit)
General Education: Natural and Applied Sciences
For students in nontechnical fields. Conceptual study of laws of nature and their application, including mechanics, heat, electricity and magnetism, light, and modern physics. One 2-hour lab per week. (Spring only)

PHYS 103 General Astronomy (3 credits)
General Education: Natural and Applied Sciences
Descriptive and physical astronomy; development of astronomical thought; properties and evolution of the solar system, stars, galaxies, and the universe. (Fall only)

PHYS 104 Astronomy Lab (1 credit)
General Education: Natural and Applied Sciences
Naked eye, telescopic, and photographic observations of constellations, stars, and planets. One 2-hour lab per week. (Fall only).

PHYS 111 General Physics I (3 credits)
General Education: Natural and Applied Sciences
Carries no credit after PHYS 211. Kinematics, forces and dynamics, conservation laws, thermodynamics, waves. Three lectures and one recitation per week.
Prereqs or Coreqs: MATH 143

PHYS 111L General Physics I Lab (1 credit)
General Education: Natural and Applied Sciences
Kinematics, forces and dynamics, conservation laws, thermodynamics, waves. One 2-hour lab per week.
Prereqs: MATH 143
Coreqs: PHYS 111

PHYS 112 General Physics II (3 credits)
General Education: Natural and Applied Sciences
Carries no credit after PHYS 212. Electricity, magnetism, optics, and modern physics. Three lectures and one recitation per week. (Spring only).
Prereqs: PHYS 111/PHYS 111L

PHYS 112L General Physics II Lab (1 credit)
General Education: Natural and Applied Sciences
Electricity, magnetism, optics, and modern physics. One 2-hour lab per week.
Prereqs: PHYS 111/PHYS 111L
Coreqs: PHYS 112

PHYS 200 (s) Physics Seminar (1 credit)
Introductory-level discussion of topics in modern physics; introduction to physics research topics and scientific information search techniques; written and/or oral reports of a pertinent topic in current physics. (Fall only)

PHYS 203 (s) Workshop (1-16 credits)
Credit arranged

PHYS 204 (s) Special Topics (1-16 credits)
Credit arranged

PHYS 209 (s) Directed Study (1-16 credits)
Credit arranged

PHYS 211 Engineering Physics I (3 credits)
General Education: Natural and Applied Sciences
Kinematics and dynamics, Newton’s laws, work and energy, rotational dynamics, linear and angular momentum, collisions, static equilibrium, oscillations, gravity and central forces. Three lectures and one recitation per week.
Prereqs or Coreqs: MATH 170

PHYS 211L Laboratory Physics I (1 credit)
General Education: Natural and Applied Sciences
Kinematics and dynamics, Newton’s laws, work and energy, rotational dynamics, linear and angular momentum, collisions, static equilibrium, oscillations, gravity, central forces, and thermodynamics. One 2-hour lab per week.
Coreqs: PHYS 211

PHYS 212 Engineering Physics II (3 credits)
General Education: Natural and Applied Sciences
Electric fields and potentials, magnetic fields, capacitance and inductance, DC and AC circuits, electromagnetic waves. Three lectures and one recitation per week.
Prereqs: PHYS 211/PHYS 211L
Prereqs or Coreqs: MATH 175

PHYS 212L Laboratory Physics II (1 credit)
General Education: Natural and Applied Sciences
Electric fields and potentials, magnetic fields, capacitance and inductance, DC and AC circuits, electromagnetic waves, mechanical waves, and geometric optics. One 2-hour lab per week.
Coreqs: PHYS 212

PHYS 213 Engineering Physics III (3 credits)
Fluid dynamics, waves in elastic media, sound waves, temperature, heat and thermodynamics, kinetic theory, geometric and physical optics. Three lectures and one recitation per week.
Prereqs: PHYS 211/PHYS 211L
Prereqs or Coreqs: MATH 175

PHYS 299 (s) Directed Study (1-16 credits)
Credit arranged

PHYS 305 Modern Physics (3 credits)
Quantum and relativity theories with applications to atomic, solid state, nuclear, and elementary particle physics. (Spring only).
Prereqs: PHYS 212/PHYS 212L
Coreqs: MATH 275 and PHYS 213

PHYS 321 Analytical Mechanics (3 credits)
Review of single-particle kinematics and dynamics; linear oscillations; Lagrangian dynamics; orbital dynamics; motion in non-inertial systems; space rotation of rigid bodies.
Prereqs: PHYS 212/PHYS 212L and MATH 275
Coreqs: MATH 310

PHYS 333 Statistical Thermodynamics (3 credits)
Cross-listed with CHEM 495
Classical thermodynamics, entropy, thermodynamic potentials, kinetic theory, classical and quantum statistical mechanics, ensembles, partition functions, introduction to phase transitions.
Prereqs: CHEM 306 or PHYS 305 or equivalent
PHYS 341 Electromagnetic Fields I (3 credits)
This course is designed to provide undergraduate physics majors advanced instruction in electrostatics. The specific areas which will be covered are electric fields, electric potentials, work and energy in electrostatics, the technique of using the concept of image charges to solve for the electric field and electric potential of complex charge distributions, Laplace’s and Poisson’s equations, electric dipoles, polarization and polarizable materials, and the electric dipole approximation.
Prereqs: PHYS 212, PHYS 212L and MATH 275

PHYS 342 Electromagnetic Fields II (3 credits)
This course is designed to provide undergraduate physics majors advanced instruction in electrodynamics and magnetism. The specific areas that will be covered are magnetostatics, magnetic fields in matter, the vector potential, electrodynamics, the complete set of Maxwell’s equations, electromagnetic waves, wavesguides, electronic and magnetic dipole radiation, retarded and advanced potentials, and radiation arising from accelerated charges and charge distributions.
Prereqs: PHYS 341

PHYS 351 Introductory Quantum Mechanics I (3 credits)
Schrodinger equation, one-dimensional systems including the free particle, bound states, potential barriers, harmonic oscillator, matrix methods, and Dirac notation; interpretations of quantum theory; quantum mechanics in three-dimensions including the hydrogen atom, angular momentum, and spin systems; identical particles; symmetries and conservation laws in quantum mechanics. Typically Offered: Spring (Odd Years).
Prereqs: PHYS 305 Coreqs: PHYS 371 or MATH 330

PHYS 371 Mathematical Physics (3 credits)
Cross-listed with MATH 371
Mathematical techniques needed in upper-division physics courses, including vector analysis, matrices, Sturm-Liouville problems, special functions, partial differential equations, complex variables.
Prereqs: PHYS 212/PHYS 212L and MATH 275

PHYS 400 (s) Seminar (1-16 credits)
Credit arranged

PHYS 403 (s) Workshop (1-16 credits)
Credit arranged

PHYS 404 (s) Special Topics (1-16 credits)
Credit arranged

PHYS 411 Advanced Physics Lab (4 credits)
Research skills, group dynamics, scientific literature research/drafting, automation and design techniques to prepare students for post-graduate life in a physics laboratory setting. 1-hour distributed lecture time and 3-hr effective lab time per week. Some weeks require scheduling machine utilization time outside of standard class hours per student.
Prereqs: PHYS 305 or Permission

PHYS 428 Numerical Methods (3 credits)
Cross-listed with ENGR 428 and MATH 428
Joint-listed with MATH 529 and PHYS 528
Systems of equations, root finding, error analysis, numerical solution to differential equations, interpolation and data fitting, numerical integration, related topics and applications. Additional projects and/or assignments required for graduate credit.
Prereqs: MATH 310

PHYS 438 Biological Physics (3 credits)
Joint-listed with PHYS 538
Physics principles applied to biological systems including organisms, cells, and biomolecules. Techniques for studying biological systems and phenomena. Additional projects/assignments required for graduate credit. Prereq for PHYS 438: PHYS 212 or PHYS 213; Junior or Senior standing. Prereq for PHYS 538: Graduate Standing or Permission.

PHYS 443 Optics (3 credits)
Joint-listed with PHYS 543
Geometrical optics, wave optics and physical optics with emphasis on modern instrumentation and methods of measurement. Additional projects/assignments required for graduate credit. Prereq for PHYS 443: PHYS 342. Prereq for PHYS 543: Admission to Physics Graduate program or Permission.

PHYS 464 Solid State Physics (3 credits)
Joint-listed with PHYS 564
Crystal structure and lattice dynamics including elastic and thermal properties of solids; electron dynamics including band theory, theory of metals and semiconductors, superconductivity, magnetism; solid-state device-physics; characterization of materials; special topics chosen by the instructor. Additional projects/assignments required for graduate credit. (Spring only).
Prereqs: PHYS 321 and PHYS 341; or Permission
Coreqs: PHYS 351 or Permission

PHYS 465 Nuclear and Particle Physics (3 credits)
Joint-listed with PHYS 565
Particle production and detection, properties and classification of particles, the quark model of hadrons, symmetries and conservation laws, interactions, grand unification, the strong interaction and nuclear forces, models for nuclear structure and reactions. Additional projects/assignments required for graduate credit. Cooperative: open to WSU degree-seeking students. Prereq for PHYS 465: PHYS 305. Prereq for PHYS 565: Admission to physics graduate program or Permission.

PHYS 484 Astrophysics (3 credits)
Joint-listed with PHYS 584
Celestial mechanics; planets and planetary systems; structure and evolution of stars and star systems; special and general relativity; cosmology. Additional projects/assignments required for graduate credit. Cooperative: open to WSU degree-seeking students. Prereq for PHYS 484: PHYS 305 or MATH 275; or Permission. Prereq for PHYS 584: Admission to physics graduate program or Permission.

PHYS 490 Research (6 credits, max 6)
Undergraduate research or thesis.
Prereqs: Permission of Instructor

PHYS 492 Senior Research (1 credit)
General Education: Senior Experience
Undergraduate research in one of the department focus areas. Scientific communication through one presentation to the scientific community and one written report. Prereq Junior or Senior Standing; or Permission of Instructor.

PHYS 498 (s) Internship (1-16 credits)
Credit arranged

PHYS 499 (s) Directed Study (1-16 credits)
Credit arranged

PHYS 500 Master’s Research and Thesis (1-16 credits)
Credit arranged
PHYS 501 (s) Seminar (16 credits)
Credit arranged. Graded P/F.
**Prereqs:** Permission

PHYS 502 (s) Directed Study (1-16 credits)
Credit arranged

PHYS 503 (s) Workshop (1-16 credits)
Credit arranged

PHYS 504 (s) Special Topics (1-16 credits)
Credit arranged

PHYS 521 Advanced Mechanics (3 credits)
Classical mechanics; Lagrange's and Hamilton's principles, two-body problem, rigid body motion, special relativity, canonical transformation, Hamilton-Jacobi theory, small oscillations, and Lagrangian and Hamiltonian formulations for continuous systems and fields. Cooperative: open to WSU degree-seeking students.

PHYS 528 Numerical Methods (3 credits)
Cross-listed with MATH 529
Joint-listed with ENGR 428, MATH 428, and PHYS 428
Systems of equations, root finding, error analysis, numerical solution to differential equations, interpolation and data fitting, numerical integration, related topics and applications. Additional projects and/or assignments required for graduate credit.
**Prereqs:** MATH 310

PHYS 533 Statistical Mechanics (3 credits)
Ensembles, partition functions, classical and quantum statistics renormalization group, criticality, scaling, interacting systems, simulation. Cooperative: open to WSU degree-seeking students.
**Prereqs:** PHYS 333

PHYS 538 Biological Physics (3 credits)
Joint-listed with PHYS 438
Physics principles applied to biological systems including organisms, cells, and biomolecules. Techniques for studying biological systems and phenomena. Additional projects/assignments required for graduate credit. Prereq for PHYS 438: PHYS 212 or PHYS 213; Junior or Senior standing. Prereq for PHYS 538: Graduate Standing or Permission.

PHYS 541 Electromagnetic Theory I (3 credits)
Analytical tools and techniques describing electromagnetic phenomena, particularly Maxwell's equations, electrostatic and magnetostatic systems, including currents and their interactions and boundary value problems. Cooperative: open to WSU degree-seeking students.
**Prereqs:** PHYS 342

PHYS 542 Electromagnetic Theory II (3 credits)
Further examinations of the analytical tools and techniques that describe electromagnetic phenomena, particularly electrodynamics, the general theory of emission, propagation and absorption of electromagnetic waves, and the relativistic formulation of electrodynamics. Cooperative: open to WSU degree-seeking students.
**Prereqs:** PHYS 541

PHYS 543 Optics (3 credits)
Joint-listed with PHYS 443
Geometrical optics, wave optics and physical optics with emphasis on modern instrumentation and methods of measurement. Additional projects/assignments required for graduate credit. Prereq for PHYS 443: PHYS 342. Prereq for PHYS 543: Admission to Physics Graduate program or Permission.

PHYS 550 Quantum Mechanics I (3 credits)
Fundamental concepts, base kets and matrix representation, position and momentum space; Schroedinger and Heisenberg picture, Schroedinger's wave equation and solutions; theory of angular momentum. Cooperative: open to WSU degree-seeking students.
**Prereqs:** PHYS 351

PHYS 551 Quantum Mechanics II (3 credits)
Theory of angular momentum continued; symmetries in quantum mechanics; approximation methods, time-dependent and time-independent perturbation theory, applications to atomic systems; radiation theory, theory of scattering. Cooperative: open to WSU degree-seeking students.
**Prereqs:** PHYS 550

PHYS 554 Solid State Physics (3 credits)
Joint-listed with PHYS 464
Crystal structure and lattice dynamics including elastic and thermal properties of solids; electron dynamics including band theory, theory of metals and semiconductors, superconductivity, magnetism; solid-state device-physics; characterization of materials; special topics chosen by the instructor. Additional projects/assignments required for graduate credit. (Spring only).
**Prereqs:** PHYS 321 and PHYS 341; or Permission
**Coreqs:** PHYS 351 or Permission

PHYS 565 Particle and Nuclear Physics (3 credits)
Joint-listed with PHYS 465
Particle production and detection, properties and classification of particles, the quark model of hadrons, symmetries and conservation laws, interactions, grand unification, the strong interaction and nuclear forces, models for nuclear structure and reactions. Additional projects/assignments required for graduate credit. Cooperative: open to WSU degree-seeking students. Prereq for PHYS 465: PHYS 305. Prereq for PHYS 565: Admission to Physics Graduate program or Permission.

PHYS 571 Mathematical Methods of Physics (3 credits)
Methods and problems. Cooperative: open to WSU degree-seeking students.
**Prereqs:** PHYS 322 or Permission

PHYS 584 Astrophysics (3 credits)
Joint-listed with PHYS 484
Celestial mechanics; planets and planetary systems; structure and evolution of stars and star systems; special and general relativity; cosmology. Additional projects/assignments required for graduate credit. Prereq for PHYS 484: PHYS 305 or MATH 275; or Permission. Prereq for PHYS 584: Admission to Physics Graduate program or Permission.

PHYS 598 (s) Internship (1-16 credits)
Credit arranged

PHYS 599 (s) Research (1-16 credits)
Credit arranged

PHYS 600 Doctoral Research and Dissertation (1-45 credits)
Credit arranged