

PHYS 545. Advanced Optics	3 Units	PHYS 563. Fluid Dynamics	3 Units
Prerequisite(s): PHYS 355 and PHYS 542; or consent of instructor.		Term Typically Offered: Spring Odd Years	
Description: Topics in optical physics including optical system design, lasers, and quantum optics.		Prerequisite(s): MATH 301 or ENGR 201 (or equivalent), or permission of instructor.	
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)		Description: An introduction to nonlinear fluid dynamics, covering kinematics (strain, rotation, transport), nonlinear conservation laws (mass, momentum, energy; dimensions forms), vorticity dynamics, viscous flows, boundary layers, shear instability, and turbulence.	
PHYS 546. Advanced Optics Lab	1 Unit	Concepts are illustrated with applications drawn from aerodynamics (lift and drag on airfoils, propulsion of fish and birds), biofluids (flow in blood vessels), compressible flow (shock waves), geophysical fluid dynamics (waves, shear instability), and turbulence (energy cascades, modeling strategies).	
Prerequisite(s): PHYS 355 or equivalent.		For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	
Fee: An additional \$25.00 is charged for this course.		PHYS 565. Advanced Computational and Numerical Methods in Physics	3 Units
Description: Laboratory experiments illustrating fundamental optical phenomena, the interaction of light and matter, lasers, and quantum optics.		Term Typically Offered: Spring Only	
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)		Prerequisite(s): PHYS 350 or PHYS 561.	
PHYS 547. Fundamentals of Lasers	3 Units	Fee: An additional \$25.00 is charged for this course.	
Term Typically Offered: Occasionally Offered		Description: Modern computational and numerical methods in physics with application to problems in different branches of physics.	
Prerequisite(s): PHYS 355; and PHYS 542 or ECE 473; or consent of instructor.		For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	
Description: Topics to be discussed include interaction of light with matter, optical amplifiers, laser resonators, Gaussian and higher order optical beams, non-linear optics, and ultra-fast laser pulses.		PHYS 570. Atomic and Molecular Physics	3 Units
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)		Term Typically Offered: Occasionally Offered	
PHYS 555. Elementary Quantum Mechanics	3 Units	Prerequisite(s): PHYS 541 and PHYS 555; or consent of instructor.	
Term Typically Offered: Fall Only		Description: The structure of atoms and diatomic molecules, the production of coherent radiation and its interaction with matter.	
Prerequisite(s): PHYS 300; PHYS 350 or MATH 405 or ENGR 205; PHYS 460.		For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	
Description: General concepts of quantum mechanics. Schrodinger equation and solutions in one, two and three-dimensions, hydrogen atom, and orbital angular momentum.		PHYS 575. Solid State Physics	3 Units
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)		Term Typically Offered: Fall Only	
PHYS 556. Quantum Theory of Matter	3 Units	Prerequisite(s): PHYS 541 and PHYS 555, or consent of instructor.	
Term Typically Offered: Spring Only		Description: Crystal structure, elastic waves, lattice dynamics, phonons, band theory of solids and conductivity phenomena.	
Prerequisite(s): PHYS 555.		For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	
Description: Spin and general angular momentum, perturbation theory, variational principle, applications, identical particles, and scattering.		PHYS 580. Nuclear Physics	3 Units
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)		Term Typically Offered: Occasionally Offered	
PHYS 561. Mathematical Physics I	3 Units	Prerequisite(s): PHYS 541 and PHYS 555; or consent of instructor.	
Prerequisite(s): PHYS 350 or MATH 405 or ENGR 205.		Description: Phenomenological study of nuclear properties. Nuclear structure and reactions, radioactive decay, interaction of charged particles with matter.	
Description: Selected mathematical techniques and their applications to various fields of physics.		For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	
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PHYS 562. Mathematical Physics II	3 Units	Term Typically Offered: Spring Even Years	
Prerequisite(s): PHYS 350 or MATH 405 or ENGR 205.		Prerequisite(s): PHYS 541 and PHYS 555, or consent of instructor.	
Description: Selected mathematical techniques and their applications to various fields of physics.		Description: Properties of elementary particles. Detectors and accelerators. Weak and electromagnetic interactions. Quark model of hadrons, strong interactions.	
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)		For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	

PHYS 589. General Relativity Term Typically Offered: Spring Even Years Prerequisite(s): PHYS 460; MATH 301 or ENGR 201. Description: Review of classical gravitation and special relativity, Riemannian geometry, Einstein field equations, exact solutions, tests of the theory, gravitational collapse and black holes, gravitational waves, cosmology. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units	PHYS 621. Quantum Mechanics I Prerequisite(s): PHYS 556 and PHYS 605, and consent of instructor. Description: Nonrelativistic quantum mechanics. Hilbert space formalism, Schrodinger and Heisenberg representations, angular momentum theory, perturbation theory, scattering theory. Systems of identical particles and symmetries. Applications. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
PHYS 590. Astrophysics Term Typically Offered: Spring Only Prerequisite(s): PHYS 307; PHYS 350 or MATH 405 or ENGR 205 (or equivalent). Description: Physics applied to the interstellar medium; the atmospheres, structure, and evolution of stars; galaxies. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units	PHYS 622. Quantum Mechanics II Prerequisite(s): PHYS 556 and PHYS 605, and consent of instructor. Description: Nonrelativistic quantum mechanics. Hilbert space formalism, Schrodinger and Heisenberg representations, angular momentum theory, perturbation theory, scattering theory. Systems of identical particles and symmetries. Applications. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
PHYS 595. Special Topics Description: Introduction to an advanced topic or elaboration of an intermediate topic not treated comprehensively in a regular course. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	1-3 Units	PHYS 625. Statistical Mechanics Prerequisite(s): PHYS 530 and PHYS 555, and consent of instructor. Description: Application of ensemble or information theory to derivation of the laws of thermodynamics for classical or quantum systems. Properties of perfect and imperfect gases, magnetic phenomena, fluctuation phenomena, and the Onsager equations. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
PHYS 601. Quantum Mechanics Laboratory Prerequisite(s): PHYS 621 or PHYS 555 (may be taken concurrently). Fee: An additional \$25.00 is charged for this course. Description: Laboratory exercises demonstrating the principles of Quantum Mechanics. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units	PHYS 640. Solid State Physics I Prerequisite(s): PHYS 575, and concurrent registration in Quantum Mechanics, and consent of instructor. Description: Quantum mechanical foundation of the theory of solids, the many-body problem, the band approximation, and other approximate methods. Electron-photon interaction, theory of superconductivity, electronic transport processes. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
PHYS 605. Theoretical Mechanics Prerequisite(s): PHYS 460 and PHYS 561, or consent of instructor. Description: Analytical dynamics of systems of particles and rigid bodies. Hamiltonian and Lagrangian formulations, special relativity, canonical transformations, Hamilton-Jacobi theory and action-angle variables. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units	PHYS 641. Solid State Physics II Prerequisite(s): PHYS 575, and concurrent registration in Quantum Mechanics, and consent of instructor. Description: Quantum mechanical foundation of the theory of solids, the many-body problem, the band approximation, and other approximate methods. Electron-photon interaction, theory of superconductivity, electronic transport processes. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
PHYS 611. Electromagnetic Theory I Prerequisite(s): PHYS 542 and PHYS 561, and consent of instructor. Description: Microscopic and macroscopic Maxwell's equations; the energy-momentum tensor; multipole radiation; radiation from accelerated charges; scattering and dispersion; and covariant formulation. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units	PHYS 650. Research Methods in Physics & Astronomy Grading Basis: Pass/Fail Fee: An additional \$25.00 is charged for this course. Description: A survey of research methodologies. Topics may include modeling and simulation, experimental, theoretical, and computational techniques used in any branch of Physics and Astronomy, particle detector technologies, advanced handling of data statistics, data mining, laboratory safety, and research ethics. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units
PHYS 612. Electromagnetic Theory II Prerequisite(s): PHYS 542 and PHYS 561, and consent of instructor. Description: Microscopic and macroscopic Maxwell's equations; the energy-momentum tensor; multipole radiation; radiation from accelerated charges; scattering and dispersion; and covariant formulation. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)	3 Units		

PHYS 670. Special Topics **1-12 Units**

Prerequisite(s): Concurrent or previous registration in PHYS 605, PHYS 611, or PHYS 621; and consent of instructor.

Description: One or more advanced topics not treated comprehensively in the regular courses.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

PHYS 690. Independent Study **1-12 Units**

Prerequisite(s): Consent of instructor.

Description: Advanced study conducted under the direction of a faculty member.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

PHYS 695. Research Seminar **1-12 Units**

Prerequisite(s): Consent of instructor.

Description: Regular but informal meetings of faculty members and graduate students active in an area of research to discuss problems of mutual interest, and to review the current literature.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)

PHYS 699. Research **1-12 Units**

Prerequisite(s): Consent of instructor.

For class offerings for a specific term, refer to the Schedule of Classes (<http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm>)