## Physics and Astronomy (PHYS)

Subject-area course lists indicate courses currently active for offering at the University of Louisville. Not all courses are scheduled in any given academic term. For class offerings in a specific semester, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm).

500-level courses generally are included in both the undergraduate- and graduate-level course listings; however, specific course/section offerings may vary between semesters. Students are responsible for ensuring that they enroll in courses that are applicable to their particular academic programs.

### Course Fees

Some courses may carry fees beyond the standard tuition costs to cover additional support or materials. Program-, subject- and course-specific fee information can be found on the Office of the Bursar website (http://louisville.edu/bursar/tuitionfee/).

<table>
<thead>
<tr>
<th>Course Code</th>
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</thead>
<tbody>
<tr>
<td>PHYS 107</td>
<td>Elementary Astronomy - S</td>
<td>3</td>
<td>Fall, Spring, Summer</td>
<td>Introduction to the basic laws of nature as seen in the large-scale structure of the universe: galaxies, stars and our solar system.</td>
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<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 108</td>
<td>Elementary Astronomy Laboratory - SL</td>
<td>1</td>
<td>Fall</td>
<td>Experiments in astronomy illustrating basic physical concepts. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
<td>Concurrent or prior registration in PHYS 107</td>
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<tr>
<td>PHYS 111</td>
<td>Elements of Physics - B</td>
<td>4</td>
<td>Fall, Spring</td>
<td>An introduction to the physics of mechanics, forces, energy and momentum. Electricity and magnetism: electrical conduction, and magnets. Optics: color, mirrors, and lenses. Basic ideas and concepts of quantum physics.</td>
<td>Appropriate math placement.</td>
<td>An additional $25.00 is charged for this course.</td>
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For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm).
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<tr>
<td>PHYS 295</td>
<td>Introductory Laboratories I - SL</td>
<td>1</td>
<td>Fall, Spring, Summer</td>
<td>PHYS 298 (or concurrently).</td>
<td>Courses of experiments in mechanics and heat. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 296</td>
<td>Introductory Laboratories II - SL</td>
<td>1</td>
<td>Fall, Spring, Summer</td>
<td>PHYS 299 (or concurrently).</td>
<td>Courses of experiments in electricity, magnetism, and light. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 298</td>
<td>Introductory Mechanics, Heat and Sound - S</td>
<td>4</td>
<td>Fall, Spring, Summer</td>
<td>MATH 205 or ENGR 101 (or concurrently in either).</td>
<td>Basic methods of physics with calculus applied to topics in mechanics, heat and wave motion. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 299</td>
<td>Introductory Electricity, Magnetism and Light</td>
<td>4</td>
<td>Fall, Spring, Summer</td>
<td>PHYS 298 and (MATH 206 or ENGR 102 (or concurrently).</td>
<td>Basic methods of physics with calculus applied to topics in electricity, magnetism and light. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 300</td>
<td>Introductory Modern Physics</td>
<td>3</td>
<td>Fall, Spring</td>
<td>PHYS 299, physics majors should take PHYS 301 concurrently.</td>
<td>Introduction to special relativity and quantum theory, with applications to atomic, nuclear, and solid state physics. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 301</td>
<td>Introductory Modern Physics Laboratory</td>
<td>1</td>
<td>Fall Only</td>
<td>PHYS 300 (or concurrently).</td>
<td>Experiments in modern physics. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 307</td>
<td>Introductory Stellar Astrophysics</td>
<td>3</td>
<td>Fall Only</td>
<td>PHYS 299, MATH 206 or ENGR 102, PHYS 300 recommended.</td>
<td>A calculus-based introduction to the physics of the solar system, and stars, covering celestial mechanics, tides, the nature of light, star and planet formation and evolution. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
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<td>PHYS 308</td>
<td>Observational Astronomy</td>
<td>1</td>
<td>Fall Only</td>
<td>PHYS 221 and PHYS 222, or PHYS 298 and PHYS 299, or equivalent.</td>
<td>Optical astronomy including observing at Moore Observatory, solar observing, instrumentation control with computers, and astronomical data acquisition and interpretation. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 310</td>
<td>Atomic and Nuclear Physics Laboratory</td>
<td>2</td>
<td>Spring Only</td>
<td>PHYS 300.</td>
<td>Experimental procedures in atomic and nuclear physics. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $50.00 is charged for this course.</td>
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<tr>
<td>PHYS 350</td>
<td>Differential Equations for the Physical Sciences</td>
<td>4</td>
<td>Fall Only</td>
<td>MATH 206 or ENGR 102 or permission of instructor.</td>
<td>Topics include methods of solution of differential equations, and simple modeling of phenomena using differential equations. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $50.00 is charged for this course.</td>
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<tr>
<td>PHYS 351</td>
<td>Atomic and Nuclear Physics Laboratory</td>
<td>2</td>
<td>Spring Only</td>
<td>PHYS 300.</td>
<td>A calculus-based introduction to the physics of the solar system, and stars, covering celestial mechanics, tides, the nature of light, star and planet formation and evolution. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<td>PHYS 355</td>
<td>Optics</td>
<td>3</td>
<td>Fall Only</td>
<td>PHYS 299.</td>
<td>Introduction to wave theory of light and relation between light waves and rays; theory of thick lenses and lens aberrations; interference and diffraction of coherent light. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 356</td>
<td>Optics Laboratory</td>
<td>2</td>
<td>Fall Only</td>
<td>PHYS 299.</td>
<td>Laboratory experiments illustrating the reflection, refraction, interference, diffraction, and polarization of light. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">link</a>)</td>
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<td>PHYS 360</td>
<td>Introduction to Weather Analysis</td>
<td>3</td>
<td>Fall Only</td>
<td>An additional $50.00 is charged for this course.</td>
<td>MATH 205 or ENGR 101.</td>
<td>A study of day-to-day weather patterns with an emphasis on understanding the basics of meteorological processes, forecast preparation, and mastery of manual data analysis. Topics covered will include manual construction of weather maps, interpreting observations, an introduction to physics of meteorological processes and the structure of circulation patterns. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<td>PHYS 361</td>
<td>Atmospheric Thermodynamics</td>
<td>3</td>
<td>Fall Only</td>
<td>An additional $50.00 is charged for this course.</td>
<td>MATH 206 or ENGR 102 with a C or better, or an ACT Math score of 24, or a SAT Math score of 550; and MATH 301 or ENGR 201 (or either concurrently).</td>
<td>An introduction to the principles of thermodynamics and their applications to atmospheric structure and dynamics. Includes the study of relationships among pressure, temperature, density, internal energy, entropy, atmospheric interaction with gravity, and the central role of water in atmospheric dynamics. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<td>PHYS 362</td>
<td>Physical Meteorology</td>
<td>3</td>
<td>Fall Only</td>
<td>An additional $50.00 is charged for this course.</td>
<td>PHYS 361.</td>
<td>An introduction to the application of physics to atmospheric structure and dynamics. Includes cloud formation, and the effects of planetary rotation on large-scale atmospheric motion. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<td>PHYS 363</td>
<td>Atmospheric Physics</td>
<td>3</td>
<td>Fall Only</td>
<td>An additional $25.00 is charged for this course.</td>
<td>MATH 206 or ENGR 102 (or equivalent), or permission of instructor.</td>
<td>This course will cover atmospheric thermodynamics, radiative transfer, cloud microphysics, planetary boundary layer, elementary atmospheric chemistry, and physics of the atmosphere. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<td>PHYS 365</td>
<td>Mesoscale Meteorology</td>
<td>3</td>
<td>Spring Only</td>
<td>An additional $50.00 is charged for this course.</td>
<td>PHYS 360.</td>
<td>Introduction to mesoscale processes, with an emphasis on convective storms and severe weather, and the techniques used for the study and prediction of such events. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<td>PHYS 371</td>
<td>Special Topics</td>
<td>3</td>
<td>Fall Only, Spring Only</td>
<td>An additional $25.00 is charged for this course.</td>
<td>Faculty consent.</td>
<td>Exploration of intermediate level of some well-defined topic not treated comprehensively in a regular course.</td>
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<tr>
<td>PHYS 375</td>
<td>Intermediate Scientific Computing and Data Analysis</td>
<td>3</td>
<td>Spring Only</td>
<td>An additional $25.00 is charged for this course.</td>
<td>PHYS 275.</td>
<td>Prerequisites or corequisites: PHYS 221 or PHYS 298; MATH 206 or ENGR 102; or faculty consent. Advances skills in programming with high-level languages (e.g. Python, Matlab, Mathematica) for physics-based modeling and analysis of real data. Students learn how to prepare input data for discovery of correlations and systematic behavior, how to effectively employ linear and multi-parameter regressions, error propagation and mitigation, and how to objectively evaluate model fits. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<tr>
<td>PHYS 390</td>
<td>Introductory Computational Physics</td>
<td>3</td>
<td>Occasionally Offered</td>
<td>An additional $25.00 is charged for this course.</td>
<td>PHYS 300 and MATH 301.</td>
<td>Introduction to the Unix/Linux operating system and the use of contemporary programming languages with applications to physics, including basic numerical methods, simulations, and data manipulation. Introduction to scientific software packages including data visualization. For class offerings for a specific term, refer to the Schedule of Classes (<a href="http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm">http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm</a>)</td>
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<tr>
<td>PHYS 430</td>
<td>Practicum in Physics Education - CUE</td>
<td>1</td>
<td>Fall, Spring</td>
<td>An additional $25.00 is charged for this course.</td>
<td>Completion of PHYS 300 and PHYS 460; PHYS majors only; permission to enroll required; minimum 3.0 GPA in major to be eligible.</td>
<td>A guided learning experience in inquiry-based instructional techniques and best practices in STEM education that includes field experience as an undergraduate teaching assistant. [Note: May be repeated for a maximum of 6 credit hours.]</td>
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</table>

For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
PHYS 450. Introductory Mathematical Physics 3 Units
Term Typically Offered: Occasionaly Offered
Prerequisite(s): PHYS 350 or ENGR 205 or MATH 405; MATH 301 or ENGR 201.
Description: Introduction to mathematical methods and concepts used in physics. Topics include: vector calculus, matrices and linear vector spaces, special functions and partial differential equations.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 460. Mechanics 3 Units
Term Typically Offered: Fall, Spring
Prerequisite(s): PHYS 298 and PHYS 350.
Description: Kinematics, particle dynamics, oscillatory motion, central forces, rigid body motion, variation methods.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 464. Atmospheric Dynamics 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): MATH 206 or ENGR 102 (or equivalent), or permission of instructor.
Description: Introduction to atmospheric dynamics, including conservation of mass, momentum, and energy, scale analysis, the Coriolis force and geostrophic balance, the thermal-wind equation and its connection to remote-sensing, and Rossby waves. The critical roles of conservation of potential vorticity and baroclinic instability in setting the synoptic scale (the separation between highs and lows) and in maintaining persistent unsteadiness in atmospheres and oceans are established.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 465. Dynamic Meteorology I 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 361.
Fee: An additional $50.00 is charged for this course.
Description: An introduction to the theory of atmospheric dynamics with application of Newtonian physics and classical thermodynamics to geophysical fluid dynamics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 466. Dynamic Meteorology II 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): PHYS 465.
Fee: An additional $50.00 is charged for this course.
Description: This is the second semester in the theory of atmospheric dynamics and dynamic meteorology. Topics may include shear instability, atmospheric waves, moist convection, and weather fluctuation.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 475. Machine Learning in the Physical Sciences 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 375.
Fee: An additional $25.00 is charged for this course.
Description: Covers the fundamentals of machine learning (ML), including the classification and regression of data using different ML tools, e.g. supervised and unsupervised learning, Monte Carlo Markov Chains (MCMC), and Bayesian methods. Students will learn the metrics of ML success applied to real data from the physical sciences, tuning hyperparameters, and the critical evaluation of ML outcomes.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 495. Communicating in Physics 1 Unit
Prerequisite(s): Senior standing.
Description: Preparation and oral presentation of scientific results in a seminar format. Organization and written presentation of scientific results in a journal format. Communication of research results through a website.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 496. Senior Seminar in Physics - CUE, WR 3 Units
Prerequisite(s): PHYS 460 and senior standing.
Description: Students will review current professional journals in the discipline and discuss effective scientific writing, including the draft and revision process. Students will write a reflect on the connections between their physics education and critical thinking models. Students will also perform a research project and present the results in journal format.
Note: Approved for the Arts and Sciences upper-level requirement in written communication (WR).
Course Attribute(s): CUE - This course fulfills the Culminating Undergraduate Experience (CUE) requirement for certain degree programs. CUE courses are advanced-level courses intended for majors with at least 90 earned credits/senior-level status.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 497. Senior Thesis in Physics - CUE, WR 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): PHYS 460 and senior standing.
Description: Students will perform original research and write up their methods and results in a multi-chapter thesis. Research projects may be a continuation of previously initiated research.
Note: Approved for the Arts and Sciences upper-level requirement in written communication (WR).
Course Attribute(s): CUE - This course fulfills the Culminating Undergraduate Experience (CUE) requirement for certain degree programs. CUE courses are advanced-level courses intended for majors with at least 90 earned credits/senior-level status.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
PHYS 498. Undergraduate Research 1-3 Units
Term Typically Offered: Fall, Spring
Prerequisite(s): PHYS 301, PHYS 350, PHYS 351 and approval of instructor.
Description: Experimental or theoretical research under the guidance of a physics faculty member. The student will participate in one of the ongoing research projects in the department. The student will acquire hands-on-experience in an actual research project. The student will produce a written report on the results of the research project. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 499. Cooperative Internship in Physics - CUE 1-3 Units
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): PHYS 295, PHYS 296, PHYS 298, PHYS 301 and 6 additional hours in Physics; Junior standing or above; approval of department.
Description: Independent research conducted with the approval and supervision 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 500. Independent Study 1-3 Units
Description: Independent research conducted with the approval and supervision 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 501. Independent Study 1-3 Units
Description: Independent research conducted with the approval and supervision 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 502. Independent Study 1-3 Units
Description: Independent research conducted with the approval and supervision 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 507. Solar System Astronomy 3 Units
Prerequisite(s): PHYS 300; MATH 206 or ENGR 102.
Description: This is an advanced course in solar system astrophysics, and will cover orbital mechanics, the nature of light, astronomical instrumentation, solar physics, planetary atmospheres/geophysics, comets/asteroids, interplanetary dust and exo-planets. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 517. Physics of Climate 3 Units
Term Typically Offered: Spring Odd Years
Prerequisite(s): MATH 206 or ENGR 102 (or equivalent) or permission of instructor.
Description: Introduction to the physics of Earth's climate system, including the energy budget of the atmosphere, oceans, and cryosphere, shortwave and longwave radiation, the effects of clouds and aerosols, and models of the greenhouse effect, climate sensitivity, atmosphere-ocean feedbacks, and climate change. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 518. Space Weather 3 Units
Term Typically Offered: Spring Even Years
Prerequisite(s): MATH 206 or ENGR 102 (or equivalent), or permission of instructor.
Description: This course provides a comprehensive overview of the physics and effects of space weather. Space weather refers to conditions on the Sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems, and affect human life or health. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 520. Vibrations and Sound 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): PHYS 298, PHYS 299 and MATH 206.
Description: Vibrating bodies, propagation of sound waves, physical acoustics, and ultrasonics. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 530. Thermal Physics 3 Units
Prerequisite(s): PHYS 299, MATH 301 or ENGR 201.
Description: The laws of thermodynamics, thermodynamic reasoning, and elements of statistical mechanics. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 531. Introductory Statistical Physics 3 Units
Prerequisite(s): PHYS 530.
Description: Elementary probability theory applied to the understanding of properties of macroscopic matter in terms of their microscopic constituents. Kinetic theory of gases, transport phenomena. Equations of state derived from ensemble theory. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 541. Electromagnetic Fields 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): PHYS 300; PHYS 350 or MATH 405 or ENGR 205; MATH 301 or ENGR 201.
Description: Electrostatic and magnetostatic fields in free space and in material media, solutions of Poisson's equation, time dependent fields, Maxwell's equations. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
PHYS 542. Electromagnetic Radiation 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): PHYS 541.
Description: Poisson's equation and Laplace's Equation, propagation of electromagnetic fields with applications to optics and microwave physics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 545. Advanced Optics 3 Units
Prerequisite(s): PHYS 355 and PHYS 542; or consent of instructor.
Description: Topics in optical physics including optical system design, lasers, and quantum optics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 546. Advanced Optics Lab 1 Unit
Prerequisite(s): PHYS 545 or equivalent.
Fee: An additional $25.00 is charged for this course.
Description: Laboratory experiments illustrating fundamental optical phenomena, the interaction of light and matter, lasers, and quantum optics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 547. Fundamentals of Lasers 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): PHYS 355; and PHYS 542 or ECE 473; or consent of instructor.
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.
Note: Cross-listed with ECE 540.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 548. Fluid Dynamics 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): PHYS 300; PHYS 350 or MATH 405 or ENGR 205; PHYS 460.
Description: 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).
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 549. Modern Computational and Numerical Methods in Physics 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): PHYS 350 or PHYS 561.
Fee: An additional $25.00 is charged for this course.
Description: Modern computational and numerical methods in physics with application to problems in different branches of physics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 551. Electromagnetism 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 300; PHYS 350 or MATH 405 or ENGR 205; PHYS 460.
Description: General concepts of quantum mechanics. Schrodinger equation and solutions in one, two and three-dimensions, hydrogen atom, and orbital angular momentum.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 552. Elementary Quantum Mechanics 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 300; PHYS 350 or MATH 405 or ENGR 205; PHYS 460.
Description: Modern computational and numerical methods in physics with application to problems in different branches of physics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 556. Quantum Theory of Matter 3 Units
Term Typically Offered: Spring Only
Prerequisite(s): PHYS 555.
Description: Spin and general angular momentum, perturbation theory, variational principle, applications, identical particles, and scattering.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 557. Atomic and Molecular Physics 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): PHYS 451 and PHYS 555; or consent of instructor.
Description: The structure of atoms and diatomic molecules, the production of coherent radiation and its interaction with matter.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 558. Solid State Physics 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 451 and PHYS 555, or consent of instructor.
Description: Crystal structure, elastic waves, lattice dynamics, phonons, band theory of solids and conductivity phenomena.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
PHYS 580. Nuclear Physics 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): PHYS 541 and PHYS 555; or consent of instructor.
Description: Phenomenological study of nuclear properties. Nuclear structure and reactions, radioactive decay, interaction of charged particles with matter.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 585. Elementary Particle Physics 3 Units
Term Typically Offered: Spring Even Years
Prerequisite(s): PHYS 541 and PHYS 555, or consent of instructor.
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)

PHYS 589. General Relativity 3 Units
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)

PHYS 590. Astrophysics 3 Units
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)

PHYS 595. Special Topics 1-3 Units
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)