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 or 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>
<th>Course Name</th>
<th>Units</th>
<th>Term Typically Offered</th>
<th>Description</th>
<th>Prerequisite(s)</th>
<th>Fee</th>
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<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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<tr>
<td>PHYS 108</td>
<td>Elementary Astronomy Laboratory - SL</td>
<td>1</td>
<td>Fall, Spring</td>
<td>Experiments in astronomy illustrating basic physical concepts.</td>
<td>Concurrent or prior registration in PHYS 107.</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 219</td>
<td>Contemporary Issues in Meteorology Lab - SL</td>
<td>1</td>
<td>Fall, Spring</td>
<td>A lab designed to provide real-world examples of atmospheric processes through analysis and problem solving using basic concepts and physical principles relevant to the atmosphere.</td>
<td>Concurrent enrollment in PHYS 220.</td>
<td>An additional $25.00 is charged for this course.</td>
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<tr>
<td>PHYS 220</td>
<td>Introduction to Weather and Climate - S</td>
<td>3</td>
<td>Fall Only</td>
<td>The topics to be covered in this course include season, temperature, pressure, wind and moisture of the atmosphere, storm system such as mid-latitude cyclones, thunderstorms, tornadoes and hurricanes, the weather forecast process, and climate change.</td>
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<tr>
<td>PHYS 221</td>
<td>Fundamentals of Physics I - S</td>
<td>3</td>
<td>Fall, Spring, Summer</td>
<td>Basic concepts and methods of physics as applied in the study of mechanics, heat and sound.</td>
<td>Appropriate Math placement.</td>
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<tr>
<td>PHYS 222</td>
<td>Fundamentals of Physics II - S</td>
<td>3</td>
<td>Fall, Spring</td>
<td>Basic concepts and methods of physics as applied in the study of electricity, magnetism, optics and modern physics.</td>
<td>PHYS 221 or PHYS 298 or equivalent.</td>
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<tr>
<td>PHYS 223</td>
<td>Fundamentals of Physics Lab I - SL</td>
<td>1</td>
<td>Fall, Spring</td>
<td>Experiments in mechanics, heat and sound.</td>
<td>PHYS 221 (or concurrently).</td>
<td>An additional $25.00 is charged for this course.</td>
</tr>
<tr>
<td>PHYS 224</td>
<td>Fundamentals of Physics Laboratory II - SL</td>
<td>1</td>
<td>Fall, Spring</td>
<td>Experiments in electricity, magnetism, and light.</td>
<td>PHYS 222 (or concurrently).</td>
<td>An additional $25.00 is charged for this course.</td>
</tr>
</tbody>
</table>

For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm).
PHYS 275. Introduction to Scientific Computing and Data Analysis 3 Units
Description: Prerequisites or corequisites: MATH 205, or ENGR 101; or faculty consent. An introduction to data analysis, statistical distributions, fitting models and functions to data, estimating uncertainties, and visualizing data. Students learn a modern scientific programming language (e.g. Python, Matlab), with examples based on real problems in the physical and life sciences.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 295. Introductory Laboratories I - SL 1 Unit
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): PHYS 298 (or concurrently).
Fee: An additional $25.00 is charged for this course.
Description: Experiments in mechanics and heat.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 296. Introductory Laboratories II - SL 1 Unit
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): PHYS 299 (or concurrently).
Fee: An additional $25.00 is charged for this course.
Description: Experiments in electricity, magnetism, and light.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 298. Introductory Mechanics, Heat and Sound - S 4 Units
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): MATH 205 or ENGR 101 (or concurrently in either).
Description: 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 (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 299. Introductory Electricity, Magnetism and Light 4 Units
Term Typically Offered: Fall, Spring, Summer
Prerequisite(s): PHYS 298 and (MATH 206 or ENGR 102 (or concurrently in either).
Description: 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 (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 300. Introductory Modern Physics 3 Units
Term Typically Offered: Fall, Spring
Prerequisite(s): PHYS 299; physics majors should take PHYS 301 concurrently.
Description: 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 (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 301. Introductory Modern Physics Laboratory 1 Unit
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 300 (or concurrently).
Fee: An additional $25.00 is charged for this course.
Description: Experiments in modern physics. For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 307. Introductory Stellar Astrophysics 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 299; MATH 206 or ENGR 102; PHYS 300 recommended.
Description: 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 (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 308. Observational Astronomy 1 Unit
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 221 and PHYS 222, or PHYS 298 and PHYS 299, or equivalent.
Description: 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 (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 350. Differential Equations for the Physical Sciences 4 Units
Term Typically Offered: Fall Only
Prerequisite(s): MATH 206 or ENGR 102 or permission of instructor.
Fee: An additional $50.00 is charged for this course.
Description: 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 (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 351. Atomic and Nuclear Physics Laboratory 2 Units
Term Typically Offered: Spring Only
Prerequisite(s): PHYS 300.
Fee: An additional $25.00 is charged for this course.
Description: Experimental procedures in atomic and nuclear physics.
For class offerings for a specific term, refer to the Schedule of Classes (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)

PHYS 355. Optics 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 299.
Description: 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 (http://htmlaccess.louisville.edu/classSchedule/setupSearchClassSchedule.cfm)
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<tbody>
<tr>
<td>PHYS 350. Optics Laboratory</td>
<td>2 Units</td>
<td>Fall Only</td>
<td>PHYS 299.</td>
<td>An additional $25.00 is charged for this course.</td>
<td>Laboratory experiments illustrating the reflection, refraction, interference, diffraction, and polarization of light.</td>
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<tr>
<td>PHYS 360. Introduction to Weather Analysis</td>
<td>3 Units</td>
<td>Fall Only</td>
<td>MATH 205 or ENGR 101.</td>
<td>An additional $50.00 is charged for this course.</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.</td>
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<td>PHYS 361. Atmospheric Thermodynamics</td>
<td>3 Units</td>
<td>Spring Only</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>Exploration of intermediate level of some well-defined topic not treated comprehensively in a regular course.</td>
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<td>PHYS 362. Physical Meteorology</td>
<td>3 Units</td>
<td>Fall Only</td>
<td>PHYS 361.</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.</td>
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<tr>
<td>PHYS 363. Atmospheric Physics</td>
<td>3 Units</td>
<td>Fall Only</td>
<td>MATH 206 or ENGR 102 (or equivalent), or permission of instructor.</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.</td>
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<tr>
<td>PHYS 365. Mesoscale Meteorology</td>
<td>3 Units</td>
<td>Spring Only</td>
<td>PHYS 360.</td>
<td>May be repeated for a maximum of 6 credit hours.</td>
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<td>PHYS 370. Special Topics</td>
<td>3 Units</td>
<td>Occasional</td>
<td>Faculty consent.</td>
<td>Exploration of intermediate level of some well-defined topic.</td>
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<tr>
<td>PHYS 371. Special Topics</td>
<td>1 Unit</td>
<td>Fall, Spring</td>
<td>PHYS 360; 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.</td>
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<td>PHYS 380. Practicum in Physics Education - CUE</td>
<td>1 Unit</td>
<td>Fall, Spring</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>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.</td>
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<td>PHYS 390. Introductory Computational Physics</td>
<td>3 Units</td>
<td>Occasionally Offered</td>
<td>PHYS 300 and MATH 301.</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.</td>
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<tr>
<td>PHYS 400. Practicum in Physics Education - CUE</td>
<td>1 Unit</td>
<td>Fall, Spring</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>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.</td>
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<td>PHYS 450. Introductory Mathematical Physics</td>
<td>3 Units</td>
<td>Occasionally Offered</td>
<td>PHYS 350 or ENGR 205 or MATH 405; MATH 301 or ENGR 201.</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.</td>
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**Note:** Topic announced in Schedule of Courses.
PHYS 460. Mechanics  
**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**  
**Term Typically Offered:** Spring Only  
**Prerequisite(s):** MATH 206 or ENGR 102 (or equivalent), or permission of instructor.  
**Description:** Introduction to atmospheric dynamics, including corevation 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**  
**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**  
**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 469. Synoptic Meteorology - CUE**  
**Term Typically Offered:** Spring Only  
**Corequisite(s):** PHYS 466.  
**Fee:** An additional $50.00 is charged for this course.  
**Description:** Employing knowledge and skills developed over the entire program, the course will examine the structure and dynamics of mid-latitude weather systems. Students will learn to integrate observations, numerical weather prediction models, and the physical principles developed in previous courses to understand the atmosphere's behavior and develop weather forecasts.  
**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 475. Machine Learning in the Physical Sciences  
**Term Typically Offered:** Fall Only  
**Prerequisite(s):** PHYS 375.  
**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**  
**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**  
**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 - WR, CUE**  
**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 an overview of the physics of interplanetary 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 355 or equivalent.
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 555. 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: 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 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 551. Mathematical Physics I 3 Units
Prerequisite(s): PHYS 350 or MATH 405 or ENGR 205.
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)

PHYS 552. Mathematical Physics II 3 Units
Prerequisite(s): PHYS 350 or MATH 405 or ENGR 205.
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)

PHYS 553. Fluid Dynamics 3 Units
Term Typically Offered: Spring Odd Years
Prerequisite(s): MATH 301 or ENGR 201 (or equivalent), or permission of instructor.
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.
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 554. Computational Physics 3 Units
Term Typically Offered: Fall Only
Prerequisite(s): PHYS 390; and PHYS 555 or PHYS 561 taken concurrently; familiarity with a programming language.
Description: Introduction to modern computational 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 557. Atomic and Molecular Physics 3 Units
Term Typically Offered: Occasionally Offered
Prerequisite(s): PHYS 541 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 541 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  
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  
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  
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  
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  
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)