Physics

Website: http://physics.wustl.edu

Courses


L31 Physics 105 General Physics
Credit 4 units.

L31 Physics 117A General Physics I
Calculus-based introduction to the concepts, laws, and structure of physics. The course is taught in a lecture-based style and requires students to complete weekly homework assignments. Topics include kinematics, Newton's laws, energy, linear momentum, angular momentum, the conservation of energy, linear momentum, angular momentum, gravitational force, harmonic motion, wave motion and interference, sound, and special relativity. Concurrent registration in a Physics 117A lab section is required. Prerequisite: Previous or concurrent enrollment in Calculus I (Math 131) is required; previous or concurrent enrollment in Calculus II (Math 132) strongly recommended. Credit may not be obtained for both Physics 117A and Physics 197 and students may not simultaneously enroll in both courses. Credit 4 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 125A Solar System Astronomy
Designed for the nonscience major, this course deals with the planets, their moons and rings, comets, meteorites and interplanetary dust particles. In order to understand both classical astronomy and the results obtained from modern telescopes and the space program, basic scientific ideas (including optics and the laws of motion) are reviewed first. There also is some discussion of astronomical history to show how we have arrived at our present ideas of the structure and evolution of the solar system. Prerequisites: high school algebra and trigonometry or concurrent enrollment in Math 131. Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 126A Stars, Galaxies and Cosmology
Intended as a general survey for the nonscience major. Topics include kinematics, Newton's laws, energy, linear momentum, angular momentum, the conservation laws, gravitational force, harmonic motion, wave motion and interference, sound, and special relativity. A daily regimen of homework and reading as well as weekly homework assignments, small-group problem-solving exercises, and active class participation are integral parts of this course. Prerequisite: previous or concurrent enrollment in Calculus I (Math 131) is required; previous or concurrent enrollment in Calculus II (Math 132) strongly recommended. Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 191 Physics I
Calculus-based introduction to the concepts, laws, and structure of physics. Topics include kinematics, Newton's laws, energy, linear momentum, angular momentum, the conservation laws, gravitational force, harmonic motion, wave motion and interference, sound, and special relativity. Two evening exams required, followed by a required final exam. Prerequisite: previous or concurrent enrollment in Calculus I (Math 131) is required; previous or concurrent enrollment in Calculus II (Math 132) strongly recommended. A combination of Physics 191 and Physics 191L is a replacement for Physics 197. Students may not receive credit for more than one of Physics 117A, Physics 191, and Physics 197. Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 191F Physics I — First-Years Only
This section of Physics 191 is for rising first-years only. Any non-first-year student enrolled in this section will be removed from the course. Non-first-year students should enroll in Physics 191U. Calculus-based introduction to the concepts, laws, and structure of physics. Topics include kinematics, Newton's laws, energy, linear momentum, angular momentum, the conservation laws, gravitational force, harmonic motion, wave motion and interference, sound, and special relativity. Two evening exams required, followed by a required final exam. Prerequisite: previous or concurrent enrollment in Calculus I (Math 131) is required; previous or concurrent enrollment in Calculus II (Math 132) strongly recommended. A combination of Physics 191 and Physics 191L is a replacement for Physics 197. Students may not receive credit for more than one of Physics 117A, Physics 191, or Physics 197. Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 142 Selected Topics in Physics I
Topics of special interest (e.g., holography, relativity, nuclear power, computer applications in physics, etc.) may be studied under the supervision of a faculty member, variously by lectures, seminars or individual study or research. Students hoping to arrange such a course must prepare a proposal and secure consent to undertake direction of the course from a faculty member and finally secure approval of the department chair. Credit variable, maximum 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 171A Physics and Society
Introduction to physics as it applies to the world we have built for ourselves. Energy as a unifying principle of physics and society's use of energy. Atoms, heat, and power. Essentials of conventional and alternative forms of energy. Nuclear energy, including radiation, waste, and weapons. Global climate change. Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 141 Selected Topics in Physics I
Topics of special interest (e.g., superconductivity, quasicrystals, neural networks, chaos, etc.) may be studied under the supervision of a faculty member, variously by lectures, seminars or individual study or research. Students hoping to arrange such a course must prepare a proposal and secure consent to undertake direction of the course from a faculty member and finally secure approval of the department chair. Credit variable, maximum 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI
L31 Physics 191L Physics I Laboratory
Laboratory experience is an integral component of introductory physics. It is designed to provide a hands-on opportunity to explore concepts introduced in the lecture course and to develop careful measurement and documentation skills. Prerequisite/ corequisite: Physics 191. Students may not receive credit for Physics 191L if they have already received credit for Physics 117A or 197.
Credit 1 unit. Arch: NSM

L31 Physics 191U Physics I — Sophomores, Juniors, and Seniors Only
This section of Physics 191 is for rising seniors, juniors, and sophomores only. Any first-year student enrolled in this section will be removed from the course. First-year students should enroll in Physics 191F. Calculus-based introduction to the concepts, laws, and structure of physics. Topics include kinematics, Newton's laws, energy, linear momentum, angular momentum, the conservation laws, gravitational force, harmonic motion, wave motion and interference, sound, and special relativity. Two evening exams required, followed by a required final exam. Prerequisite: previous or concurrent enrollment in Calculus I (Math 131) is required; previous or concurrent enrollment in Calculus II (Math 132) strongly recommended. Combination of Physics 191 and Physics 191L is a replacement for Physics 197. Students may not receive credit for more than one of Physics 117A, Physics 191, and Physics 197.
Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 192 Physics II
Continuation of Physics 191. Calculus-based introduction to concepts, laws, and structure of physics. Topics include electromagnetic forces and fields, direct current circuits, capacitance and inductance, electromagnetic radiation, light, physical optics, interference and diffraction, early quantum theory, and nuclear physics. A daily regimen of homework and reading as well as weekly homework assignments, small group problem-solving exercises, and active class participation are integral parts of this course. Prerequisite: Physics 191, Physics 197, or Physics 117A; Calculus I (Math 131); previous or concurrent enrollment in Calculus II (Math 132) is very strongly recommended. Students may not receive credit for more than one of Physics 118A, Physics 192, and Physics 198.
Credit 3 units. A&S IQ: NSM, AN BU: SCI

L31 Physics 192L Physics II Laboratory
Laboratory experience is an integral component of Introductory Physics. It is designed to provide a hands-on opportunity to explore concepts introduced in the lecture course and to develop careful measurement and documentation skills. Prerequisite/ Corequisite: Physics 192. Students who have taken Physics 118 or Physics 198 may not receive credit for Physics 192L.
Credit 1 unit.

L31 Physics 193 Focused Physics I
Physics 193 is the first part of a two-semester calculus-based introduction to physics. The course is an advanced first-year course in classical mechanics, taught at a more sophisticated level than Physics 191. The approach is that of an upper-division physics course, with more emphasis on underlying formal structure rather than breadth of topics. The main goal is to provide in-depth coverage of the physical laws that govern the motion of objects, forces, and forms of energy in mechanical systems as well as an introduction to special relativity. The course is particularly addressed to students considering a physics- or mathematics-heavy science or engineering major.
Corequisite: Math 132 or equivalent.
Credit 4 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 193L Focused Physics I Laboratory
Laboratory experience is an integral component of Introductory Physics. It is designed to provide a hands-on opportunity to explore concepts introduced in the lecture course and to develop careful measurement and documentation skills. Required prerequisite or co-requisite: Physics 191. Students may not receive credit for Physics 191L if they have already received credit for 117A or 197.
Same as L31 Physics 191L
Credit 1 unit. Arch: NSM

L31 Physics 201 Honors Problem Solving I
This is a problem-solving course for students considering a physics- or mathematics-heavy major. The problems we will focus on will be more difficult and sophisticated than those encountered in Physics 197. However, the content will be tightly linked to the weekly schedule of Physics 197, and the course will be taught by a Physics 197 instructor. This course is for incoming first-year students and rising sophomores. Prerequisites: concurrent enrollment in Physics 197 or AP physics and permission of the instructor.
Credit 1 unit. Arch: NSM

L31 Physics 204 Honors Problem Solving II
This is the second semester of a problem-solving course for students considering a physics- or mathematics-heavy major. The problems we will focus on will be more difficult and sophisticated than those encountered in Physics 192. However, the content will be tightly linked to the weekly schedule of Physics 192, and the course will be taught by a Physics 192 instructor. This course is for incoming first-year students and rising sophomores. Prerequisite: previous enrollment in Physics 201, concurrent enrollment in Physics 192, or permission of the instructor.
Credit 1 unit.

L31 Physics 205 General Physics I
This course is the first semester of a two-semester, calculus-based introductory physics course. In this semester, we will study the principles of Newtonian mechanics and their application to various physical systems. The material we learn this semester will serve as a basis for topics we will study in the second semester, such as electromagnetism. The aim of this course is to give you a robust introduction to the fundamentals of physics. Studying physics will also give you a better insight into other subjects like chemistry. The analytic techniques we develop will have a wide range of availability. Prerequisite: previous enrollment in Calculus I.
Credit 3 units. A&S IQ: AN

L31 Physics 205L General Physics I Lab
The laboratory experience is an integral component of Introductory Physics. It is designed to provide a hands-on opportunity to explore concepts introduced in the lecture course and to develop careful measurement and documentation skills. Prerequisite or Corequisite: Physics 205.
Credit 1 unit.
L31 Physics 216 Introduction to Relativity: The Special Theory
Introduction to the special and general theories of relativity. Einstein's postulates of the principle of relativity and the constancy of the speed of light. Simple kinematics and dynamics: simultaneity, time dilation, space-time diagrams, twin and other "paradoxes," \( E=mc^2 \), laws of motion. Elements of general relativity; curved spacetime, experimental tests, black holes, gravitational waves. Prerequisite: Physics 117A, Physics 197 or permission of the instructor.
Credit 1 unit. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 217 Introduction to Quantum Physics
Theoretical and experimental basis for quantum mechanics, following the historical development of 20th-century physics. Failure of classical physics; the Bohr theory of the atom; the Heisenberg uncertainty principle; the Schroedinger equation; atomic and molecular structure. Prerequisites: Physics 117A and 118A or Physics 197 and 198.
Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 241 Selected Topics in Physics II
Topics of special interest (e.g., superconductivity, quasicrystals, neural networks, chaos, etc.) may be studied under the supervision of a faculty member, variously by lectures, seminars or individual study or research. Students hoping to arrange such a course must prepare a proposal and secure consent to undertake direction of the course from a faculty member and finally secure approval of the department chair.
Credit variable, maximum 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 242 Selected Topics in Physics II
Topics of special interest (e.g., holography, relativity, nuclear power, computer applications in physics, etc.) may be studied under the supervision of a faculty member, variously by lectures, seminars or individual study or research. Students hoping to arrange such a course must prepare a proposal and secure the instructor's consent to undertake direction of the course from a faculty member and finally secure approval of the department chair.
Credit variable, maximum 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: IS

L31 Physics 316 Optics and Wave Physics Laboratory
Introduction to optics and to treatment of experimental data. Experiments and lectures on refraction, interference, diffraction, polarization and coherence properties of waves with emphasis on light. Data analysis using statistical methods. Prerequisites: Physics 117A--Physics 118A or Physics 197--Physics 198.
Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 318 Introduction to Quantum Physics II
Application of elementary quantum principles to atomic and molecular physics, solid-state physics, and nuclear and particle physics. Prerequisite: Physics 217.
Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI
EN: BME T, DU, SU, TU

L31 Physics 321 Electronics Laboratory
Elements of linear and nonlinear circuits, amplifiers, feedback, with applications in experimental physics. Prerequisite: Physics 118A, Physics 198 or permission of instructor. Two three-hour laboratories and two one-hour lectures a week.
Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI
EN: BME T, DU, SU, TU

L31 Physics 322 Physical Measurement Laboratory
A variety of classical and modern experiments in physics, including five experiments in nuclear radiation. Use of computers in experiment control, data acquisition, and data analysis. Development of skills in writing lab notebooks and formal reports and giving short oral presentations on experiments. Two laboratory periods each week. Prerequisites: Physics 217 or permission of instructor; junior- or senior-level standing.
Credit 3 units. A&S IQ: NSM, AN, WI Arch: NSM Art: NSM BU: SCI EN: TU

L31 Physics 341 Selected Topics in Physics III
Topics of special interest (e.g., superconductivity, quasicrystals, neural networks, chaos, etc.) may be studied under the supervision of a faculty member, variously by lectures, seminars or individual study or research. Students hoping to arrange such a course must prepare a proposal and secure consent to undertake direction of the course from a faculty member and finally secure approval of the department chair.
Credit variable, maximum 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 342 Selected Topics in Physics III
Topics of special interest (e.g., holography, relativity, nuclear power, computer application in physics, etc.) may be studied under the supervision of a faculty member, variously by lectures, seminars or individual study or research. Students hoping to arrange such a course must prepare a proposal and secure the instructor's consent to undertake direction of the course from a faculty member and finally secure approval of the department chair.
Credit variable, maximum 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 344 Energy and Environmental Physics
This intermediate-level course applies basic physics principles to this increasingly important area. It is designed for all science and engineering majors with an interest in energy and environmental issues. Topics covered include population trends, fossil fuel use, renewable energy sources, energy storage strategies and
climate change. Particular emphasis is given to the use of the fundamental laws of physics, such as energy conservation, as well as more general concepts such as local and global stability, chaotic behavior, probability and risk. The aim of the course is the development of analytical skills and familiarity with important concepts, in order to enable an independent and informed view of environmental problems and possible solutions. A one-year introductory physics class on the level of Physics 117–118 or 197–198 is required. This course also may be taken as Physics 444, which requires an additional independent project.
Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI

L31 Physics 350 Physics of the Brain
Concepts and techniques of physics are applied to study the functioning of neurons and neuronal circuits in the brain. Neurons and neural systems are modeled at two levels: (1) at the physical level, in terms of the electrical and chemical signals that are generated and transmitted, and (2) at the information-processing level, in terms of the computational tasks performed. Specific topics include: neuronal electrophysiology, neural codes, neural plasticity, sensory processing, neural network architectures and learning algorithms, and neural networks as dynamical and statistical systems. Course grade is based primarily on an individualized term project. Prerequisites: Physics 117A–118A, Physics 197–198, or permission of the instructor.
Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI EN: BME T, SU, TU

L31 Physics 351 Introduction to Biomedical Physics
Principles and application of key physical methods used in the diagnosis and treatment of diseases, and in biomedical research. Topics include interaction of radiation with living systems; fundamentals of optical and electron microscopy; imaging via X-rays, magnetic resonance and ultrasound; and electrical properties of organs and cells. Prerequisite: Physics 117A–118A or Physics 197–198.
Credit 3 units. Arch: NSM Art: NSM BU: SCI EN: BME T, SU, TU

L31 Physics 352 Physics of Biomolecules
This course emphasizes the application of physical laws and concepts in understanding biomolecules and their interactions, and in developing tools to investigate their biological properties and functionalities. Topics include (1) a general introduction to biomolecules and cells, (2) physics of biopolymers as modeled by stochastic analyses, (3) transport processes in biological systems including diffusion, reaction kinetics and "life at low Reynolds number," and (4) the physics of fluorescence and its contemporary applications to dynamics of biomolecules, such as optical tweezers. Prerequisite: Physics 117–118 or Physics 197–198. Some familiarity with thermodynamics; Chem 111A–112A recommended.
Credit 3 units. A&S IQ: NSM, AN Arch: NSM

L31 Physics 354 Physics of Living Systems
One of the grand challenges in contemporary biophysics is placing our understanding of cellular systems on a firm quantitative footing. How does the collective activity of molecules enable the cell to sense its environment, make decisions, grow and develop? This course, aimed at physical and life science students, will serve as an introduction to the physical principles and mathematical techniques underlying the analysis of systems and synthetic biology. Topics will include modeling gene and signaling networks, the regulation of intracellular structures, and pattern formation in development. Students in this course can expect to learn both analytical and computer simulation approaches to fundamental problems in biology, biophysics, and biotechnology. Graduate students will explore the subject in more depth. Prerequisites: Physics 117A-118A or Physics 197-198 or Math 217 or Math 309, or permission of instructor.
Credit 3 units. A&S IQ: NSM Arch: NSM BU: SCI EN: BME T, TU

L31 Physics 355 Physics of Vision
How do the eyes capture an image and convert it to neural messages that ultimately result in visual experience? This lecture and demonstration course covers the physics of how we see. The course is addressed to physics, premedical and life-sciences students with an interest in biophysics. Topics include physical properties of light, evolution of the eyes, image formation in the eye, image sampling with an array of photoreceptors, transducing light into electrical signals, color coding, retinal organization, computing with nerve cells, compressing the 3-D world into optic nerve signals, inferring the 3-D world from optic nerve signals, biomechanics of eye movement, engineered vision in machines. The functional impact of biophysical mechanisms for visual experience is illustrated with psychophysical demonstrations. Corequisite: Physics 117A, Physics 197 or permission of instructor.
Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI EN: BME T, SU, TU

L31 Physics 360 Biophysics Laboratory
This laboratory course consists of "table-top" experiments in biological physics that are designed to introduce the student to concepts, methods and biological model systems in biophysics. Most experiments combine experimentation with computer simulations. The list of available experiments includes electrophysiology, human bioelectricity, optical tweezers, ultrasonic imaging, mass spectrometer and viscosity measurements. Prerequisites: prior completion of Physics 117A–118A, Physics 197–198 or permission of instructor.
Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM

L31 Physics 400 Physical Science in 12 Problems
Exercises related to general chemistry, classical mechanics, quantum mechanics, statistical mechanics, thermodynamics, and kinetics, will be solved with numerical software. Each exercise will be accompanied by a lecture, a software template solving a problem and a related take-home problem. The software will allow us to focus on, and treat in a transparent fashion, physical problems without the unworldly idealizations and contrivances found in textbooks. Prerequisites: General Chem, concurrent enrollment with Chem 401 and prior or concurrent enrollment in Physics 117A, 197, or 191L.
Same as L07 Chem 400
Credit 1 unit. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 411 Mechanics
Motion of a point particle, rotational motion, oscillation, gravitation and central forces, Lagrangian and Hamiltonian formulation. Prerequisite: Phys 197-198, Math 217, or permission of instructor.
Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM
L31 Physics 421 Electricity and Magnetism
Starting from Coulomb's law, the Biot-Savart law and Faraday's law, the electrical and magnetic fields are defined and applied. Maxwell's equations are derived and their consequences, such as electromagnetic waves and relativity, are explored. Prerequisites: Physics 117A–118A or Physics 197–198, Math 217 or permission of instructor. Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM BU: SCI EN: BME T, DU, SU, TU

L31 Physics 422 Electricity and Magnetism II
The second course in a two-part series covering the classical theory of electricity and magnetism leading to the derivation and application of Maxwell's equation. Topics in electrodynamics including Faraday's law, the displacement current and Maxwell's equations in vacuum and in matter are covered. Electromagnetic waves and radiation, special relativity and relativistic electrodynamics also are discussed. Prerequisite: Physics 421 or permission of instructor. Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM EN: BME T, DU, SU, TU

L31 Physics 427 Introduction to Computational Physics
What does it mean to solve a research problem using a computer? What is the difference between "someone ran a simulation" and an interesting research result? What skills are needed? Familiarity with a programming language is, of course, essential, but that is only the beginning. This course will focus on the methodology of computational research, touching also on topics in numerical analysis, statistics, and visualization. The format will combine lectures and hands-on experience with an emphasis on research-style small-group projects. Prerequisites: Physics 197/198, calculus, and familiarity with a programming language. Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L31 Physics 435 Nuclear and Radiochemistry Lab
Application of radiochemical techniques to problems in chemistry, physics, and nuclear medicine. Prerequisites: 3 units of physical chemistry and permission of instructor. One lecture hour and five hours of laboratory a week. Same as L07 Chem 435. Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L31 Physics 436 Introduction to the Atomic Nucleus
Introduction to the production and decay of radioactive nuclides, the structure and properties of nuclei, and the applications of nuclear and radiochemical techniques to current scientific problems. Prerequisites: one year each of chemistry, mathematics and physics. Same as L07 Chem 436. Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L31 Physics 441 Selected Topics in Physics IV
Topics of special interest (e.g., holography, relativity, nuclear power, computer applications in physics, etc.) may be studied under the supervision of a faculty member, variously by lectures, seminars or individual study or research. Students hoping to arrange such a course must prepare a proposal and secure the instructor's consent to undertake direction of the course from a faculty member and finally secure approval of the department chair. Credit variable, maximum 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 442 Selected Topics in Physics IV
Topics of special interest (e.g., holography, relativity, nuclear power, computer applications in physics, etc.) may be studied under the supervision of a faculty member, variously by lectures, seminars or individual study or research. Students hoping to arrange such a course must prepare a proposal and secure the instructor's consent to undertake direction of the course from a faculty member and finally secure approval of the department chair. Credit variable, maximum 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L31 Physics 446 Galactic Astrophysics
In these lectures, the focus is on the dynamics and statistical mechanics of a collection of stars, which is treated as a collisionless system. The course begins with a discussion of potential theory and proceeds to discuss the density and phase distributions of stars in star clusters and galaxies, thus leading to an understanding of the equilibria and stability of these systems. Topics such as Chandrasekhar's dynamical friction, galaxy formation, and dark matter will constitute the final topics of discussion. Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L31 Physics 450 Physics of the Brain
Contents are the same as Physics 350. Also intended for graduate students. Includes a more sophisticated term project than Physics 350. Prerequisites: Physics 117A–118A or Physics 197–198, or permission of instructor. Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI EN: BME T, SU, TU

L31 Physics 453 Topics in Theoretical Biophysics
Application of a range of physical models to biological systems. Topics include protein folding, self-assembling molecular systems, and mechanical properties of biological materials. Background material will be provided, but some exposure to statistical mechanics or thermodynamics is necessary. Prerequisite: experience with ordinary differential equations (as in Mathematics 217). Credit 3 units. A&S IQ: NSM BU: SCI

L31 Physics 454 Physics of Living Systems
Contents are the same as Physics 354. Graduate students will explore the subject in more depth. Prerequisites: Physics 117A–118A or Physics 197–198 or Math 217 or Math 309, or permission of instructor. Credit 3 units. A&S IQ: NSM Arch: NSM EN: TU

L31 Physics 455 Physics of Vision
Contents are the same as Physics 355. Also intended for graduate students. Includes a more sophisticated term project than Physics 355. Corequisite: Physics 117A , Physics 197 or permission of instructor. Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM
L31 Physics 456 Stellar Astrophysics
The course Stellar Astrophysics discusses the physical processes that play a role inside stars. Relevant physical processes include emissions and absorption processes, radiation transfer, convective transfer, the weak and strong interactions, nuclear processes and nuclear burning, and the thermodynamics of equilibrium and non-equilibrium processes in stellar interiors. Subsequently, these processes are used to explain the structure and evolution of stars of different mass ranges. Finally, the course discusses endpoints of stellar evolution including white dwarfs, neutron stars, black holes, supernova explosions and gamma-ray burst. Prerequisites: Physics 312, Physics 318, or permission of instructor. Same as L31 Physics 556
Credit 3 units.

L31 Physics 460 X-Ray & Gamma-Ray Astrophysics
Observers started to use X-ray and gamma-rays in the '60s and '70s to explore the cosmos with high-energy photons. The sky looks dramatically different at these energies with bright flares from mass accreting black holes and gamma-ray bursts and large diffuse emission from supernova remnants and cosmic rays interacting with galactic matter and magnetic fields dominating the emission. This course gives a comprehensive overview of the underlying physics and observable phenomenology. Topics covered include the history of X-ray and gamma-ray astronomy, high-energy radiation processes, particle heating and acceleration, accretion physics, blast waves and shocks, black holes, neutron stars, supernova remnants, gamma-ray bursts, and galaxy clusters. Prerequisite: L31 Physics 312.
Credit 3 units. A&S IQ: NSM Arch: NSM

L31 Physics 463 Statistical Mechanics and Thermodynamics
Basic methods of classical and quantum statistical mechanics, thermodynamics and transport theory. Prerequisite: Physics 217 or permission of instructor.
Credit 3 units. A&S IQ: NSM, AN Arch: NSM Art: NSM

L31 Physics 471 Quantum Mechanics
Origins of quantum theory, wave packets and uncertainty relations, Schrödinger's equation in one dimension, step potentials and harmonic oscillators, eigenfunctions and eigenvalues, Schrödinger's equation in three dimensions, the hydrogen atom, symmetry, spin and the periodic table, approximation methods for time independent problems, quantum statistics. Prerequisite: Math 217, Physics 217, or permission of instructor.
Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM EN: BME T, SU, TU

L31 Physics 472 Solid State Physics
Crystal structures, binding energies, thermal properties, dielectrics, magnetism, free electron theory of metals, band theory, semiconductors, defects in solids. Prerequisite: Physics 471.
Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L31 Physics 474 Introduction to Particle Physics
Introduction to the standard model of particle physics, including symmetries, conservation laws, the weak interaction, the strong interaction, quark confinement and some more exotic ideas such as grand unified theories. Prerequisite: Physics 471.
through puzzle-based assignments. The primary modules will be supplemented by shorter presentations on topics chosen by students. Fair warning: This is explicitly not a course on “big data” or machine learning, although students may choose to explore some of these topics in their presentations (required for credit). Experience with MatLab or Python strongly encouraged or will need to be acquired during the course. Open to undergraduates with prior programming experience and a quantitative background (Phys 197/198, Math 203 or similar; contact instructor if unsure). Experience with data or statistics not required. Course mimics a research environment, and undergraduates considering an academic research track are especially encouraged.

Credit 3 units. Arch: NSM Art: NSM BU: SCI

L31 Physics 482 Research Seminar
Designed to introduce students to current developments in physics and to research carried out by faculty. Topics vary each year. Each member of the department addresses their particular specialty. Interested undergraduates may take this seminar in their junior or senior year. Must be taken pass/fail.
Credit 1 unit. A&S IQ: NSM Arch: NSM Art: NSM

L31 Physics 499 Honors Program
Prerequisites: junior standing, an average grade of B or better, and permission of the chair of the department. Program and credit to be determined; maximum 6 units.
Credit variable, maximum 3 units.