

446. Metaphysics, Part II
Winter of even-numbered years. 4(3-0)
445 or approval of department.
Continuation of 445.

447. Philosophy of Mind
Winter. 4(3-0) Three credits in philosophy at 300 level or higher or 9 credits in philosophy or approval of department.
Examines classical and contemporary treatments of such concepts as "mind", "self", "intentionality", "mental act", and associated problems (the body-mind relation, "thinking" machines, the connection of thought with action, etc.).

450. History of Esthetic Theory
Spring. 4(3-0) Three credits in philosophy at 300 level or higher or 9 credits in philosophy or 9 credits in art, music or literature or approval of department.
Poetics of Aristotle, and the tradition which it has generated in critical reflection on theory of poetry, the drama, and fine arts.

460. Moral and Political Issues
Fall, Winter, Spring. 4(3-0) Three credits in philosophy at 300 level or higher or 9 credits in philosophy, or approval of department.
Philosophical aspects of such issues as freedom of speech and action, civil disobedience, violence, war, justice and equality, human rights and punishment.

470. Formal Semantics
Winter. 4(3-0) 337 and 338 or approval of department.
Consideration of topics in formal semantics including problems associated with the construction of semantical meta-languages. Works by such authors as Carnap, Tarski, Quine and Martin will be studied.

471. Philosophy of Mathematics
Spring. 4(3-0) 337 and 338 or approval of department.
An analysis of the nature of mathematical truth. The theses of logicism, formalism, intuitionism, and conventionalism are critically examined.

480. Philosophy of Science, Part I
Fall. 4(3-0) Six credits in philosophy at the 300 level or higher, or nine credits other than basics, in natural science, social science or mathematics, or approval of department.
Philosophy of formal science, including naive set theory and theory of relations, logic and the informal axiomatic method, fundamentals of probability theory and statistics.

481. Philosophy of Science, Part II
Winter. 4(3-0) 480 or 338 or approval of department.
Nature and problems of theory construction and concept formation in science. Topics include empirical testability, explanations, prediction, and problems of induction and confirmation.

482. Philosophy of Science, Part III
Spring. 4(3-0) 481 or approval of department.
Continuation of 481.

483. Philosophy of Physical Science
Fall, Spring. 4(4-0) Nine credits in physical science or approval of department. Interdepartmental with and administered by Lyman Briggs College.
Philosophical problems of the physical sciences. The topics will be taken from such areas as: quantum mechanics, space-time, classical mechanics, relativity.

484. Philosophy of Biological Sciences
Winter, Spring. 4(4-0) Nine credits in science or approval of department. Interdepartmental with and administered by Lyman Briggs College.
Methodological notions and problems of the biological sciences such as: observation and measurement, classification, teleological and functional explanation, teleological systems, emergentism, vitalism, value neutrality.

485. Philosophy of the Social Sciences
Spring. 4(3-0) Three credits in philosophy at 300 level or higher or 9 credits in philosophy or 9 credits, other than basics, in social science or approval of department.
Selected problems in the methodology of the behavior sciences, including such topics as: concept formation and theory construction, explanation and insight, subjectivity and value judgments, emergence and teleology, historicism, reductionism, measurement, and statistical inference.

494. Special Topics
Fall, Winter, Spring, Summer. 2 to 6 credits. May re-enroll for credit. Approval of department.
Intensive study of some particular problem or author in philosophy.

825. Seminar in the History of Philosophy
Fall, Winter, Spring. 4 credits. Approval of department.

830. Seminar in Ethics
Winter, Spring, Summer. 4 credits. May re-enroll for credit. Approval of department.

837. Seminar in Logic, Part I
Fall. 4(3-0) May re-enroll for credit. Approval of department.

838. Seminar in Logic, Part II
Winter. 4(3-0) Approval of department.
Continuation of 837.

839. Seminar in Logic, Part III
Spring. 4(3-0) Approval of department.
Continuation of 838.

841. Seminar in Epistemology
Fall, Winter, Spring. 4 credits. May re-enroll for credit. Approval of department.

845. Seminar in Metaphysics
Fall, Winter, Spring. 4 credits. May re-enroll for credit. Approval of department.

850. Seminar in Aesthetics
Fall. 4(3-0) Approval of department.
The nature of aesthetic values, grounds of criticism, function of the arts, etc.

860. Seminar in Social Philosophy
Spring. 4(3-0) Approval of department.
Philosophy of law and of the state.

870. Seminar in the Philosophy of Language
Fall. 4(3-0) Approval of department.
Concrete bases of language and nature of meaning.

880. Seminar in the Philosophy of Science
Fall, Winter. 4 credits. Approval of department.

890. Graduate Reading Course
Fall, Winter, Spring, Summer. 1 to 10 credits. May re-enroll for credit. Approval of department.
Supervised reading course for advanced graduate students for more thorough investigation of special fields.

899. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

999. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

PHYSICAL SCIENCE PHS

College of Natural Science

203. Foundations of Physical Sciences
Fall, Winter, Spring, Summer. 4(3-3) Primarily for elementary school teachers.
Integrated descriptive course in the elements of physical science including the interrelations among chemistry, geology, meteorology, astronomy, and physics.

401. Mathematics for Teachers
Fall. 4(4-0) Teaching experience and approval of department.
Provides mathematical background for science teachers. It will emphasize the basic concepts of mathematics, including number systems. Topics will be selected from algebra, analytic geometry and trigonometry to illustrate the principles of number, operation, relation, proof and other basic mathematical ideas.

402. Mathematics for Teachers
Fall, Winter. 4(4-0) 401 or approval of department.
Continuation of 401.

403. Mathematics for Teachers
Winter, Spring. 4(4-0) 402 or approval of department.
Continuation of 402.

404. Physical Science for Teachers
Fall, Winter, Spring. 4(3-3) Bachelor's degree.
An integrated course in the physical sciences on the nature of the matter and energy gained by interrelating the facts, principles and laws about light, electricity, magnetism and sound as well as the structure and properties of substances, rates of reaction, equilibria. The concepts of measurement will be stressed. The course is for general science teachers and is not applicable for chemistry or physics majors.

405. Physical Science for Teachers
Fall, Winter, Spring. 4(3-3) 404.
Continuation of 404.

406. Physical Science for Teachers
Fall, Winter, Spring. 4(3-3) 405.
Continuation of 405.

410. Seminar on Recent Advances in Physical Science
Fall, Winter, Spring, Summer. 3(3-0) May re-enroll for a maximum of 6 credits if different topic is taken. Approval of department.
A series of lectures by senior faculty of topics on the history, development, the most recent advances and the possible future and limits of the Physical Sciences.

411. Seminar on Man, His Universe
Fall, Winter, Spring, Summer. 3(3-0)
Approval of department.

A creative review by senior faculty from Astronomy, Biochemistry, Biophysics, Geology, Physics and Philosophy on the impact of recent space probes in developing modern concepts of the universe.

412. Seminar on Man, His Earth
Fall, Winter, Spring, Summer. 3(3-0)
Approval of department.

A summary by senior faculty from Astronomy, Anthropology, Botany, Geology, Meteorology, and Zoology of new ideas, methods, and theories employed by current researchers to unravel the mysteries of the origin of the earth, its interior, the forces developing the scenic surface features, and the evolution of life in its historical setting.

PHYSICS

PHY

College of Natural Science

Introductory courses are divided into three groups:

- (1) 237, 238, 239 (theory) and 257, 258, 259 (laboratory) open to students who are taking at the same time, or who have taken, first year mathematics through college algebra and trigonometry.
- (2) 287, 288, 289 (theory) and 297, 298, 299 (laboratory) for students of engineering, physical sciences, mathematics, and others. Those electing this sequence should have completed courses in mathematics through two terms of analytic geometry and calculus.
- (3) 291, 292, 293, 294, 392, 393, 394, 395 for physics majors and others who have a special interest in physics. Students electing this sequence should have completed or should be taking the second term of analytic geometry and calculus.

A student may change from one group of introductory courses to another but may not receive credit for the equivalent of more than one complete three-term introductory sequence.

Credit may not be earned for more than one of the courses PHY 294, 357 or 364.

PHY 357 and 360 cannot be used to meet the requirements for a major in physics.

All 400 level physics courses require PHY 289 or 293 as prerequisites.

237. Introductory Physics
Fall, Winter. 3(4-0) MTH 102 or 109 or 111 or concurrently.
Mechanics and heat.

238. Introductory Physics
Winter, Spring. 3(4-0) 237.
Heat, electricity and magnetism.

239. Introductory Physics
Fall, Spring. 3(4-0) 238.
Wave motion, sound, light, and modern developments.

257. Introductory Physics Laboratory
Fall, Winter. 1(0-2) 237 or concurrently.
Mechanics and heat.

258. Introductory Physics Laboratory
Winter, Spring. 1(0-2) 238 or concurrently.
Heat, electricity and magnetism.

259. Introductory Physics Laboratory
Fall, Spring. 1(0-2) 239 or concurrently.
Wave motion, sound, light and modern developments.

287. Principles of Physics
Fall, Winter. 4(5-0) MTH 113.
Mechanics.

288. Principles of Physics
Winter, Spring. 4(5-0) 287; MTH 214 or approval of department.
Heat and thermodynamics, electricity and magnetism.

289. Principles of Physics
Fall, Spring, Summer. 4(5-0) 288; MTH 214 or approval of department.
Wave motion, sound, light, and modern developments.

291. Physics I
Spring. 4(5-0) MTH 214 or concurrently.
First of a five-term course sequence in elementary physics consisting of 291, 292, 293, 294 and 395. In this sequence the principles of physics are presented in a unified manner that emphasizes modern concepts. Mechanics, including special relativity.

292. Physics II
Fall. 4(5-0) 291; MTH 215 or concurrently.
Continuation of 291. Electricity and magnetism with some special relativity.

293. Physics III
Winter. 4(5-0) 292.
Continuation of 292. Wave physics including optics.

294. Physics IV
Spring. 4(5-0) 293 or 289.
Continuation of 293. Introduction to quantum physics.

297. Principles of Physics Laboratory
Fall, Winter. 1(0-2) 287 or concurrently.
Mechanics.

298. Principles of Physics Laboratory
Winter, Spring. 1(0-2) 288 or concurrently.
Heat and thermodynamics, electricity and magnetism.

299. Principles of Physics Laboratory
Fall, Spring, Summer. 1(0-2) 289 or concurrently.
Wave motion, sound, light and modern developments.

310. Calculus Concepts in Physics
Fall, Summer. 5(5-0) 237, 238, 239; MTH 214.
A transition course to prepare students who had non-calculus introductory physics for upper-division courses. Discussions and problems in mechanics, electricity and magnetism, wave motion and modern physics. Familiarity with non-calculus introductory physics is assumed.

357. Topics in Contemporary Physics
Spring. 4(4-0) One year of general college physics.
Atomic and nuclear physics, cosmic rays and elementary particles, nuclear energy, new theoretical concepts. Recommended for prospective high school teachers.

360. Introduction to Radioactivity
Summer. 3(2-3) One year of college physics or approval of department.
Elementary nuclear properties and processes emphasizing nature of radioactivity and its measurement. Special attention given to experimental techniques used with radioisotopes, and their associated radiations provide physical background for biological and industrial applications.

364. Introduction to Modern Physics I
Fall, Winter, Spring. 3(3-0) 289 or 293 or approval of department.
Atomic structure; wave and particle aspects of radiant energy; optical and X-ray spectra.

365. Introduction to Modern Physics II
Winter, Spring. 3(3-0) 364 or 294.
Nuclear, molecular, solid state and elementary particle physics. Special emphasis is given to applications such as reactors, super conductors, semi-conductors, fusion reactions, particle accelerations, etc.

368. Elementary Solid State Physics I
Winter. 3(3-0) 364 or 294.
Crystal structure and binding; lattice dynamics, specific heat, thermal conductivity; free electron theory of metals, conductivity, optical properties; elementary band theory; Hall effect, effective masses in metals and semi-conductors.

369. Elementary Solid State Physics II
Spring. 3(3-0) 368.
Ferroelectricity, paramagnetism, ferromagnetism, antiferromagnetism, domain walls; point defects, and dislocations in metals, formation and motion energies, internal friction, radiation damage.

392. Physics II Laboratory
Fall. 1(0-3) 292 or concurrently.
Experiments in classical mechanics and electricity and magnetism.

393. Physics III Laboratory
Winter. 1(0-3) 293 or concurrently.
Experiments in wave motion and optics.

394. Physics IV Laboratory
Spring. 1(0-3) 294 or concurrently.
Experiments in general and modern physics.

395. Physics V
Fall. 3(3-0) 294 or approval of department.
Continuation of 294. Thermodynamics and statistical physics.

400H. Honors Work
Fall, Winter, Spring. Variable credit.

404. Special Problems
Fall, Winter, Spring, Summer. 1 to 5 289 or 293; approval of department.

419. Electronics
Spring. 3(2-3) EE 345.
Electron tube and electric circuits designed for control and physical measurement. Laboratory work provides direct study of characteristics of tubes and circuits.

427. Intermediate Mechanics
Fall. 3(3-0) 289 or 293; MTH 215.
Statics and dynamics of a particle and of rigid bodies; linear and non-linear oscillations; gravitation from a field point of view; transformation properties of physical quantities; introduction to mathematical techniques of theoretical physics.