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 upperdivision 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 credits. 289 or 293; approval of department.

419. Electronics

Spring. 3(2-3) E E 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.

428. *Intermediate Mechanics*
Winter. 3(3-0) 427.

Continuation of 427.

429. *Advanced Mechanics*
Spring. 3(3-0) 428.

Advanced methods of theoretical mechanics; generalized coordinates; Lagrange's and Hamilton's equations; the wave equation, theory of vibrations.

438. *Optics*
Winter. 4(3-3) 289 or 293; MTH 215.

Geometrical and physical optics. Treatment of thick lens theory, interference, diffraction and polarization phenomena, and propagation of light in material media.

439. *Optics*
Spring. 4(3-3) 438.

Continuation of 438.

447. *Electricity and Magnetism I*
Winter. 4(4-0) Eighteen credits in physics, including 289 or 293; MTH 215.

Advanced study of electromagnetic phenomena; electrostatic potentials from Laplace's and Poisson's equations; effects of dielectric and magnetic materials; magnetic fields and potentials; induced e.m.f.; Maxwell's equations; electromagnetic radiation and waves.

448. *Electricity and Magnetism II*
Spring. 4(4-0) 447.

Continuation of 447.

457. *Advanced Physics Laboratory*
Fall, Winter, Spring. 2(0-6) May re-enroll for a maximum of 6 credits. 15 credits in physics including 289 or 293.

Laboratory courses consisting of experiments in modern physics of historical interest and in research techniques in solid-state and nuclear physics. Emphasizes experimental methods and proper treatment and interpretation of data. Independent work encouraged.

491. *Introduction to Quantum Mechanics*
(467.) Fall. 3(3-0) 294 or 364; MTH 215.

Schroedinger wave equation and its applications; angular momentum; one electron atoms; moments and spin; perturbation methods; absorption and emission of radiation; atomic and molecular structure.

492. *Introduction to Quantum Mechanics II*
(468.) Winter. 3(3-0) 491.

Continuation of 491.

493. *Introduction to Quantum Mechanics III*
(469.) Spring. 3(3-0) 492.

Continuation of 492.

498. *Introduction to Nuclear Physics*
Spring. 3(3-0) 294 or 364 or 491.

Interactions of nuclear radiations with matter; properties of nuclei; alpha, beta, gramma decay; nuclear models; nuclear reactions and elementary applications of scattering theory; reactors, accelerators; introduction to high-energy physics.

817. *Techniques of Theoretical Physics I*
Fall. 2(2-0) Graduate students; or approval of department.

Formulation of physical problems and practical methods of solving frequently encountered differential and integral equations including numerical methods; approximations appropriate to physical situations are stressed.

818. *Techniques of Theoretical Physics II*
Winter. 2(2-0) 817.

Special functions of importance to theoretical physics are described. Solution of physical problems using Green's Functions, the delta function, expansions in series, integral transforms.

819. *Techniques of Theoretical Physics III*
Spring. 2(2-0) 818, MTH 423.

Application of methods of contour integration to solution of physical problems; introduction to basic concepts involved in theoretical formulation of quantum mechanical states, observables, and development of dynamical systems.

827. *Theoretical Physics I*
Summer of odd-numbered years. 3(3-0) 428 or approval of department.

Vector analysis, mechanics of a particle and of systems of particles. Lagrange's equations, Hamiltonian methods, rotational motion.

828. *Theoretical Physics II*
Summer of even-numbered years. 3(3-0) 448 or approval of department.

Special relativity, Maxwell's equations, electrodynamics and electromagnetic waves.

829. *Theoretical Physics III*
Spring. Summer of odd-numbered years. 3(3-0) Approval of department.

Principles of thermodynamics; topics in kinetic theory; introduction to statistical mechanics.

837. *Quantum Mechanics I*
Fall. 3(3-0) 428, 491.

The formulation of quantum mechanics, superposition principle, state vector and representations; uncertainty principle; Schroedinger equation and its solution for physical systems.

838. *Quantum Mechanics II*
Winter. 3(3-0) 837.

Approximation methods, perturabation theory, applications to atomic transitions, angular momentum.

839. *Quantum Mechanics III*
Spring. 3(3-0) 838.

Collision processes and scattering theory, applications; many-particle systems.

840. *Symmetry in Solid State Physics*
Spring. 3(3-0) Graduates or approval of department.

Translational symmetry and Bloch's Theorem, reciprocal lattice, Brillouin zones; point groups, representations, character tables, molecular vibrations, group of the wave vectors and band theory of solids, crystal fields.

847. *Electromagnetic Theory I*
Fall. 3(3-0) 428, 448.

Electrostatics; Laplace's equation, Poisson's equation; Green's theorem; solution of problems by method of images; inversion; boundary-value problems in Cartesian, spherical and cylindrical coordinates; spherical harmonics; Bessel functions.

848. *Electromagnetic Theory II*
Winter. 3(3-0) 847.

Multipoles and multipole expansions; electrostatics of macroscopic materials, dielectrics, magnetostatics, vector potential, magnetic moments, Maxwell's equations for time-varying fields, energy and momentum conservation. Plane electromagnetic waves and polarization.

849. *Electromagnetic Theory III*
Spring. 3(3-0) 848.

Wave guides and resonant cavities, boundary-value problems. Simple radiating systems, antennas. Special relativity, covariance of electrodynamics, transformation of electromagnetic fields. Radiation by moving charges, Lienard-Wiechert potentials.

857. *Theoretical Mechanics I*
Fall. 2(2-0)

Two-body central force problems, rigid body motion, small oscillations, Hamilton's principle, Lagrangian and Hamiltonian formalism for particles and fields, canonical transformations, relativity.

858. *Theoretical Mechanics II*
Winter. 2(2-0) Approval of department.

Hamiltonian formalism for particles and fields, variational methods, canonical transformations.

859 *Theoretical Mechanics III*
Spring. 2(2-0) Approval of department.

Small oscillations, classical fields, relativity.

860. *General Relativity and Cosmology*
Fall of even-numbered years. 3(3-0) 859 or approval of department. Interdepartmental with the Astronomy Department.

The relativistic gravitational field equations will be developed and experimental evidence for their validity will be discussed; various relativistic cosmological models and their relation to astronomical evidence will be presented.

867. *Quantum Mechanics IV*
Fall. 3(3-0) 839.

Transformation theory and invariance principles; the rotation group and theory of angular momentum; Wigner-Eckart theorem and applications.

868. *Relativistic Quantum Mechanics*
Winter. 3(3-0) 867.

Relativistic equations of motion; Dirac equation, free particle solutions and Lorentz transformation properties; interaction with electromagnetic fields; quantization of scalar, electromagnetic and Dirac fields.

869. *Quantized Fields*
Spring. 3(3-0) 868.

Heisenberg representation, S-matrix reduction formulae, Feynman rules, quantum electrodynamics; topics from many-body theory.

877. *Equilibrium Statistical Mechanics*
Fall. 3(3-0) Approval of department.

Ensembles, partition functions, thermodynamic potentials with applications to simple thermodynamics; topics from many-body theory.

878. *Nonequilibrium Statistical Mechanics*
Winter. 3(3-0) 877.

Time-dependent Liouville equation, Bloch equation, and master equation, with application to relaxation processes and atomic, molecular, and nuclear systems.

879. *Quantum Statistical Mechanics*
Spring. 3(3-0) 878.

Green's function techniques with application to transport theory, superconductivity, magnetism.

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

927. Elementary Particle Physics
Fall. 3(3-0) 869.

Properties of elementary particles; invariance principles and conservation laws; strong, electromagnetic, and weak interactions; pion physics.

928. Elementary Particle Physics
Winter. 3(3-0) 927.

Baryon and meson resonances, unitary symmetry, dispersion relations.

929. Elementary Particle Physics
Spring. 3(3-0) 928.

Selected current topics, partial wave amplitudes and Regge poles; current algebra and weak interactions.

937. Molecular Structure and Spectra I
Fall of odd-numbered years. 3(3-0) 837 or concurrently.

Structure and spectra of diatomic molecules.

938. Molecular Structure and Spectra II
Winter of even-numbered years. 3(3-0) 937.

Structure and spectra of polyatomic molecules.

939. Molecular Structure and Spectra III
Spring of even-numbered years. 3(3-0) 938.

Advanced topics in vibration-rotation theory of polyatomic molecules.

947. Solid State Physics I
Fall. 3(3-0) 839 and 840.

Crystal symmetry, crystal binding, lattice vibrations and specific heat, one-electron theory; Hartee-Fock equation, Brillouin zones.

948. Solid State Physics II
Winter. 3(3-0) 947.

Effective mass approximation. Exchange and correlation corrections. Theory of conductivity and related effect, metals and semiconductors.

949. Solid State Physics III
Spring. 3(3-0) 948.

Ionic crystals. Imperfections in crystals, plastic deformations, color centers. Optical properties. Rectification, transistors, selected topics.

957. Nuclear Physics I
Fall. 3(3-0) 867.

Nucleon-nucleon scattering, nuclear sizes and shapes, multipole moments; shell model; collective states.

958. Nuclear Physics II
Winter. 3(3-0) 957.

Experimental methods and instrumentation; nuclear reactions; inelastic scattering and particle transfer.

959. Nuclear Physics III
Spring. 3(3-0) 958.

Many-body methods in nuclear physics; Bethe-Goldstone equation; effective interaction; nuclear models.

960. Techniques in Nuclear and Particle Physics
Fall. 3(3-0) Approval of department.

Properties of accelerators and particle beams, passage of radiation through matter, particle detection, pulse electronics, statistics, on-line computation.

961. Accelerator Physics
Winter. 3(3-0) 849, 859.

Cyclotrons, betatrons, synchrotrons, and linear accelerators. Theory of magnetic focussing: constant gradient, alternating gradient, edge focussing. Acceleration processes, longitudinal motion. Non-linear resonances, stability limits. Beam injection, extraction, and transport.

984. Advanced Readings in Physics
Fall, Winter, Spring, Summer. Variable credit.

987. Advanced Topics in Physics
Fall, Winter, Spring. 3(3-0) or 4(4-0)

In any one term this course will be devoted to a single topic, such as advanced quantum theory, quantum electrodynamics, specialized topics in solid state physics, statistical mechanics, relativity theory and cosmology.

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

PHYSIOLOGY PSL

College of Human Medicine
College of Natural Science
College of Osteopathic Medicine
College of Veterinary Medicine

240. Introductory Physiology
Fall, Spring, Summer. 4(3-2) Sophomores or approval of department.

Survey of the physiology of circulatory system, excretion, nervous system and special senses, digestion, metabolism and endocrinology.

241. Introductory Physiology
Winter, Summer. 4(3-2) 240.

Continuation of 240. Physiology of muscle function and neuro-muscular relationships; exercise; respiration; changes in organ systems in relation to muscular exercise.

323. Physiology, Anatomy, and Hygiene of the Eye
Fall. Summer of even-numbered years. 3(2-2) 240; Elementary Education or Special Education major, or approval of department.

Basic course in anatomy, physiology, and hygiene of the visual system; includes discussion of normal visual functioning and abnormal visual functioning, with methods of correction and education implications.

331. Human Physiology
Winter. 4(3-2) ANT 316; CEM 132, or approval of department.

332. Human Physiology
Spring. 4(3-2) 331.

401. Comparative Physiology I
(412.) Fall. 4(3-4) 240 or B S 212 and CEM 132. Interdepartmental with Department of Zoology.

A comparison of osmoregulation, digestion, respiration, and other physiological processes in a wide range of organisms.

402. Comparative Physiology II
Winter. 4(4-0) 401 or approval of department. Interdepartmental with and administered by the Department of Zoology.

A comparison of sensory, motor, endocrine and other integrative mechanisms in animals.

416. Physiology of the Cell
Fall. 3(3-0) CEM 242 or 353.

Physiologic mechanisms common to all living cells with emphasis on those of the vertebrates. The functions of the cell membrane and cytoplasm are studied as the basis for the physiologic behavior of vertebrate organs and systems.

417. Physiology of the Cell
Summer. 4(3-3) 4(6-6) 5 weeks. This is equivalent to 3 hours of lecture and 3 hours of laboratory on a ten-week basis. Approval of department.

Physiologic mechanisms common to all living cells with emphasis on those of the vertebrates. The functions of the cell membrane and cytoplasm are studied as the basis for the physiologic behavior of vertebrate organs and systems.

440. Avian Physiology
Spring of odd-numbered years. 4(3-3) Approval of department. Interdepartmental and administered jointly with the Poultry Science Department.

A survey of the systemic physiology of birds emphasizing digestion, metabolism, the endocrines, and reproduction.

444. Milk Secretion
Winter. 4(3-2) Interdepartmental and administered jointly with the Dairy Science Department.

Anatomy of mammary gland. Hormonal and nervous control of mammary growth, initiation and maintenance of lactation. Biochemistry of milk secretion. Physiology of milking; physiological, pathological and management factors affecting lactation.

445. Endocrinology and Reproduction of Farm Animals
Fall. 4(3-2) 240. Interdepartmental and administered jointly with the Dairy Science Department.

Endocrine and reproductive systems are presented with emphasis upon characteristics which can be altered for economic benefit and upon causes, prevention, and treatment of endocrine abnormalities.

480. Special Problems
Fall, Winter, Spring, Summer. 1 to 5 credits. Approval of department.

501. Advanced Mammalian Physiology
Winter, Summer. 5(5-0) Approval of department.

Basic aspects of cellular physiology: membrane permeability, ionic equilibria, bioelectric phenomena, fluid and electrolyte environment of cells. Neuro-muscular physiology; reflexes, central and autonomic nervous systems; sensory physiology. Endocrine gland system; digestion and metabolism.

502. Advanced Mammalian Physiology
Fall, Spring. 6(5-4) 501.

Continuation of 501; reproduction; blood and cardiovascular system; respiration and kidney.

808. Advanced Endocrinology
Winter. 3(3-0) Approval of department.

Current developments on anatomy, physiology, chemistry, and regulation of the major endocrine glands; nervous and hormonal control of reproduction and lactation.