I. Undergraduate Courses (100-499 level) for 500 and above, see page 6

AE 316

Aerospace Engineering Materials (3,0)
3 Credits
Structure, properties, and processing of engineering materials. Crystal structure, defects, imperfections, and strengthening mechanisms. Mechanical properties, fracture mechanics, fatigue and creep, and material failures. Phase diagrams and transformations. Degradation of materials. Characteristics of ferrous and nonferrous metals and alloys, ceramics, polymers, and composite materials. Emphasis on materials and processes used in the aerospace industry.

EE 335

Electrical Engineering I (2,0)
2 Credits
Introduction of the fundamentals of electrical engineering. Circuit theory and variables. Voltage-current relationship for passive elements. Circuit analysis and network solutions. Phasors and frequency-domain analysis. Transient analysis of first and second order systems. Equivalent circuits and power.

EE 336

Electrical Engineering Laboratory I (0,3)
1 Credit
Laboratory experiments and techniques in electrical engineering.

EGR 111

Engineering Drawing (2,0)
2 Credits
Freehand pencil sketching for graphical communication of engineering designs. Standard forms for design graphic and view layout, orthographic projection, section and auxiliary views, dimensioning, tolerancing, and introduction to shop processes.

EP 101

Current Topics in Space Sciences (1,0)
1 Credit
A survey seminar intended to explore contemporary topics encountered in the exploration of the upper atmosphere and near space environment.

EP 320

Electro-Optical Engineering (3,0)
3 Credits
Geometrical optics of mirrors, thin and thick lenses, prisms, and systems. Ray tracing with optical CAD. Fiber optics applications. Physical optics including interference, diffraction, and polarization. Phaser methods. Engineering considerations in choice of different types of detectors. Space systems applications. Image processing. Emphasis on design.

EP 340

Introduction to Space Systems Design (2,1.5)
2 Credits
An introduction to space mission analysis and design process, mission characterization, evaluation, and requirements definition. Introduction to computer aided design (CAD). Numerical modeling and simulation of engineering systems, the finite element method, the finite difference method.

EP 391

Microcomputers and Electronic Instrumentation (2,3)
3 Credits
This course will provide students with a background in electronics as it applies to the design of circuits of measuring instruments and to interface sensors and computers. The program of study will concentrate on following the form of the electrical signal from light, pressure, temperature, and other sensors as it proceeds through signal conditioning circuits and into the microcomputer for further processing. In the laboratory portion of the course the student will explore the design of pertinent regulated power supplies, amplifiers, logic circuits, filters, stepper motors, servo motors, and A-to-D and D-to-A converters. This work will serve as the basis for design project assignments to produce one or two working instruments that are interfaced to a microcomputer.

EP 393

Spaceflight Dynamics (2,0)

2 Credits

Basic topics in analytical dynamics, two body orbits and the initial value problem, the two body orbital boundary value problem, Earth coverage and space mission geometry, non-Keplerian effects, orbital maneuvers and rendezvous, and interplanetary transfer. Fundamentals of ascent flight mechanics, launch vehicle selection, fundamentals of entry flight mechanics, and the associated thermal control problem.

EP 394

Space Systems Engineering (3,0)

3 Credits

Development of the fundamental principles used in the engineering and design of space systems. Several major subsystems including power, telemetry and command, communications, thermal control and guidance, navigation, and control subsystems are covered. Topics on space environmental control and life support systems, space system integration and testing, and space system operations are also discussed.

EP 399

Special Topics in Engineering Physics

1-4 Credits

Individual, independent, or directed study of topics in the fields of applied physics, space systems, and allied engineering disciplines. Student design projects involve significant engineering design such as microgravity experiments and moon-buggy design. May be considered as an engineering elective with approval of the program coordinator.

EP 400

Thermodynamics and Statistical Mechanics (3,0)

3 Credits

Basic thermodynamics, entropy, kinetic theory, distribution of molecular velocities, Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics, microcanonical ensemble, canonical ensemble.

EP 410

Space Physics (3,0)

3 Credits

Origin, evolution, and structure of neutral and ionized terrestrial atmosphere. Effect of sun's electromagnetic radiation on ozone shield. Photoionization and thermal structure of the neutral atmosphere as well as the ionosphere and magnetosphere. Solar disturbances and their effects on satellite orbit decay and on long distance communication. Studies of composition, thermodynamics, and physical processes of the near-Earth space environment. Rocket and satellite monitoring and remote sensing. Numerical and instrument design projects.

EP 420

Planetary Science (3,0)

3 Credits

Study of the planetary system: origin, evolution, composition, present configuration, dynamics, interiors, surfaces, atmospheres, and magnetospheres of the planets and, where appropriate, similar aspects of the satellites, asteroids, and comets. Interpretations of existing data and definition of future experiments to aid in determination of the origin and evolution of the solar system are stressed.

EP 425

Observational Astronomy (2,3)

3 Credits

Basic design and use of an optical telescope, fundamentals of astronomical optics including refracting and reflecting systems, principles and applications of optical filters and adaptive optics. Design optimization and trade-offs in an observing system. Telescope system calibration and techniques for enhancing tracking accuracy. Visual observation and analysis of images of the sun, moon, planets, stars, nebulae, and galaxies. Electronic imaging including quantification of radiant energy, spectroscopy, and techniques for reducing the effects of noise sources. Optical and detector design trade-offs for measurement optimization.

EP 440

Engineering Electricity and Magnetism (3,0)

3 Credits

Solutions of electrostatics problems using Poisson's equation and Laplace's equation, electrostatic energy, electric current, magnetic field, electromagnetic induction, physics of plasmas, Maxwell's equations, and application of Maxwell's equations (reflection, refraction, waveguides, antenna radiation). Students will write some simple computer programs.

EP 455

Quantum Physics (3,0)

3 Credits

The Schrodinger equation in one and three dimensions and its solutions for step potentials, the harmonic oscillator, and the hydrogen atom. Operators and their matrix representations: Dirac bracket formalism, angular momentum and spin, and spin-orbit interaction. Identical particles and exchange symmetries. Time-independent and time-dependent perturbation theory and approximation methods: transition rates, Fermi's rule, scattering theory. Classical and quantum statistical distributions.

EP 496

Space Systems Design I (1,3)

2 Credits

A program of undergraduate research, supervised by physics or engineering faculty, leading to the writing of a technical design report in an area of current interest in engineering physics.

EP 497

Space Systems Design II (2,4)

3 Credits

This is a required course in the Engineering Physics program. It is the second of a two-semester sequence and completes senior design project requirements of this program. Continuation and completion of EP 496.

EP 199-499

Special Topics in Engineering Physics

1-4 Credits

Individual, independent, or directed study of topics in the fields of applied physics, space systems, and allied engineering disciplines. Student design projects involve significant engineering design such as microgravity experiments and moon-buggy design. May be considered as an engineering elective with approval of the program coordinator.

ES 201

Statics (3,0)

3 Credits

A vector treatment of the concepts and characteristics of forces and couples. Distributed forces. Center of mass, centroid. Equilibrium of particles and rigid bodies. Trusses and frames. Internal forces. Shear and moment distribution in beams. Area moments of inertia.

ES 202

Solid Mechanics (3,0)

3 Credits

The concepts of stress and strain and their tensor properties. Elastic stress-strain relations. Analysis of stress and deformation in members subject to axial, torsional, bending, and combined loading. Column stability.

ES 204

Dynamics (3,0)

3 Credits

A vector treatment of the kinematics and kinetics of particles and rigid bodies. Acceleration, work, energy, power, impulse, and momentum.

ES 206

Fluid Mechanics (3,0)

3 Credits

Physical characteristics of the fluid state. Fluid statics. Kinematics of fluid motion. Flow of an incompressible ideal fluid. Impulse-momentum principles. Similitude and dimensional analysis, fluid measurements.

ES 305

Thermodynamics (3,0)

3 Credits

A study of the concepts of heat and work and their transformation as governed by the first and second laws of thermodynamics. Properties of pure substances. Ideal gas behavior and relationships. Reversible processes and temperature-entropy diagrams. Conventional power cycles. Properties of ideal gas mixtures. Combustion.

HON 150

Honors Seminar I (3,0)

3 Credits

This course is open only to freshmen enrolled in the Honors program, and will satisfy the lower-level Humanities requirement in general education. An interdisciplinary Humanities course, it focuses on aesthetic, philosophical, and historical aspects of a subject, making use of text materials from several disciplines and varied media. The course also emphasizes student participation in a seminar discussion format and requires that students develop their research, critical thinking, and oral and written communication abilities. Requirements will include (but will not be limited to) text and Web-based original research, written essays, oral presentations, and participation in group discussion. Topics may vary according to instructor.

HON 250

Honors Seminar II (3,0)

3 Credits

This course is open only to students enrolled in the Honors program, and will satisfy 3 credits of the lower-level Social Sciences requirement in general education. The course focuses on material pertinent to one or more disciplines in the broad arena of the Social Sciences. Specific emphases will vary by instructor. The course also emphasizes student participation in a seminar discussion format and requires that students develop their research, critical thinking, and oral and written communication abilities. Requirements will include (but will not be limited to) text and Web-based original research, written essays, oral presentations, and participation in group discussion.

HON 350

Honors Seminar III (3,0)

3 Credits

Honors Seminar III will satisfy either the Humanities or the Social Sciences upper-level elective requirement in general education. Building on the previous two Honors seminars, it will require students to further develop their ability to locate and assess primary and secondary research materials, to present effective verbal and written presentations that display more sophisticated research and presentational sensibilities, and to engage in discussion that is rooted in close reading of assigned and unassigned material. Whatever the specific course topic, the seminar will be an interdisciplinary exploration of the subject, will emphasize student participation in focused class discussion, and will foster further development of research, critical thinking, and oral and written communication abilities. Topics vary by instructor.

MA 441

Mathematical Methods for Engineering & Physics I (3,0)

3 Credits

Line and surface integrals; vector fields with the study of Green, Gauss, and Stokes Theorems; applications of vector field theory; Fourier series.

MET 200

Machine Shop Laboratory (0,3)

1 Credit

Introduction to machine shop techniques including familiarization with riveting, sheet metal forming, welding, and machining.

PS 160

Physics for Engineers II (3,0)

3 Credits

Special theory of relativity, rotational motion, simple harmonic motion, waves, fluids, heat, kinetic theory, and thermodynamics.

PS 210

Physics II Laboratory (0,1)

1 Credit

One three-hour laboratory session per week with experiments chosen primarily from fluids, temperature, heat, first and second laws of thermodynamics, wave motion, and acoustics.

PS 215

Physics I (3,0)

3 Credits

Estimations, order of magnitude analysis, Newton's Law, gravitation, kinematics, work and energy, momentum, rotation, and harmonic motion.

PS 216

Physics I Laboratory (0,3)

1 Credit

One three-hour laboratory session per week, with experiments chosen primarily from mechanics.

PS 219

Physics III (3,0)

3 Credits

Static electricity, Gauss's Law, potential, Ohm's Law, direct current circuits, magnetic fields, induced electromotive force, inductance, EM waves, the nature of light, images formed by mirrors and lenses and optical instruments.

PS 220

Physics III Laboratory (0,3)

1 Credit

One three-hour laboratory session per week with experiments chosen primarily from thermodynamics, electricity and magnetism, and geometric optics.

PS 290

Physics Laboratory Practicum (0,1)

0 Credit

Required, noncredit course. Requires the student to direct the operation of a basic laboratory for one semester. Includes laboratory preparation, laboratory discussion, and grading of laboratory reports.

PS 301

Astronomy (3,0)

3 Credits

A descriptive course dealing with the structure and evolution of the physical universe. Topics include the solar system (Earth, Moon, Sun, and planets), stars, black holes, galaxies, quasars, cosmology, and exobiology. Planetarium trips and night-observing sessions optional.

PS 303

Modern Physics (3,0)

3 Credits

Modern concepts in physics including optics. Topics include refraction, diffraction, and scattering of electromagnetic radiation, special relativity, wave-particle duality, the uncertainty principle, quantum theory of atomic structure, X-rays, lasers, and nuclear reactions.

PS 305

Modern Physics Laboratory (0,3)

1 Credit

Experiments in atomic and nuclear physics, including spectroscopy, nuclear particle analysis, X-ray analysis, and laser applications.

PS 320

Classical Mechanics (3,0)

3 Credits

Fundamentals of mechanics, oscillatory motion, systems of particles, varying mass, motion under central forces, motion in three dimensions, gyroscopic motion, generalized coordinates, normal coordinates, Lagrangian and Hamiltonian formulations. Students will write some simple computer programs.

PS 400
Senior Physics Laboratory I (2,3)
3 Credits
Study of geometrical and physical optics including plane waves, mirrors, lenses, emission and absorption line spectroscopy, diffraction gratings, lasers, and interferometers.

PS 401
Astrophysics (3,0)
3 Credits
Study of the basic physical processes operating in the astronomical environment, stellar structure and evolution, the interstellar medium, galaxies, and cosmology. Astrophysical concepts are emphasized, thus underlining the common features operating in many astronomical systems.

PS 405
Atomic/Nuclear Physics (3,0)
3 Credits
Multi-electron atoms, X-rays and gamma rays, radiative transitions in the atom and the nucleus. Basic properties of nuclei, systematics of nuclear stability, dynamics of nuclear reactions, nuclear models, and nuclear forces. Introduction to particle physics and its applications to cosmic rays, stellar energy, and the formation of the elements.

PS 408
Astrophysics II (3,0)
3 Credits
Radiative transfer in astrophysical environments; stellar atmospheres, stellar interiors, and gaseous nebulae. Emission and absorption processes. Interaction of radiation with matter.

II. Graduate Courses (500-701)

EP 501
Numerical Methods for Engineers and Scientists
3 Credits
Numerical methods for the solution of engineering physics problems; systems of linear equations, ordinary differential equations including onedimensional initial value problems and boundary value problems; partial differential equations (PDEs) including elliptic, parabolic, and hyperbolic PDEs; finite difference method. Application to problems such as diffusion, transport, remote sensing, inversion, and plasma waves. Emphasis will be on computer implementation of numerical solutions.

EP 505
Advanced Spacecraft Dynamics and Control
3 Credits
Review of dynamic systems modeling and analysis; classical and modern linear and nonlinear control techniques; orbital dynamics, orbital maneuvers and control. Attitude sensors and sensing techniques. Passive attitude control techniques including spin, dual-spin, gravity-gradient, and magnetic stabilization. Active control using gas jet thrusters, momentum wheels, reaction wheels, and control moment gyros. Application of optimal control techniques to spacecraft maneuver problems; design of open loop and feedback controls for linear and nonlinear spacecraft dynamical systems; case studies.

EP 509
Advanced Space Physics
3 Credits
Plasma physics applied to the interplanetary medium and planetary magnetospheres: solar wind. Magnetohydrodynamics. Interaction between planetary magnetospheres and the solar wind. Auroral dynamics. Planetary atmospheres and ionospheres. Magnetosphere-ionosphere coupling. Energetic particle dynamics. Ring currents. The space radiation environment. Space weather. Satellite missions to Earth and other planets.

EP 600

Experimental Methods in Space Science

3 Credits

Measurement techniques for ground-based, rocket, and satellite-borne experiments are explored. Advantages, disadvantages, and limitations are quantitatively developed. In situ atmospheric composition measurements, charged particle detection for plasma characterization, optical remote sensing, and imaging techniques are included.

EP 605

Spacecraft Power and Thermal Design

3 Credits

Spacecraft power and thermal energy management. Spacecraft power systems; sources of power; power subsystem function and design; energy storage devices; future concepts in spacecraft power systems. Review of the modes of heat transfer: conduction, radiation, and convection. Space environment, heating fluxes. Spacecraft thermal analysis. Thermal control hardware and design; active and passive thermal control. Emphasis on the design needs of instruments and their detector systems' power and thermal requirements.

EP 700

Master of Science in Space Science Thesis

1-9 Credits

A master-level research project in Space Science/Engineering Physics including an oral thesis defense and a written report satisfying all graduate school guidelines. The work is supervised by the student's advisor and thesis committee. The approval of the thesis committee is required to receive final thesis credit.

EP 701

Analytical Techniques in Engineering Physics

This is a graduate course on mathematical techniques in engineering physics. It focuses on the application of advanced mathematical topics including Fourier and wavelet analysis, functional analysis, rotation groups and algebras, Legendre polynomials and functions, and Bessel, Hermite and Laguerre polynomials to space science and spacecraft engineering problems.

MA 502

Boundary Value Problems

3 Credits

Basic techniques of solving boundary-value problems of partial differential equations by employing the methods of Fourier series orthogonal functions, operational calculus including Laplace transforms, other integral transforms, and Cauchy's residue calculus. Applications to heat transfer, fluid mechanics, elasticity, and mechanical vibrations. Computer applications.