ENGINEERING and PHYSICS (Updated August 3, 2018)

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The Department of Engineering and Physics offers programs of study leading to a Bachelor of Science degree in Engineering, a Bachelor of Science degree in Classical Physics and a Bachelor of Science degree in Physics with Teacher Licensure.

Bachelor of Science Degree in Engineering

The engineering program is built upon a strong foundation in mathematics, science, and engineering fundamentals. Graduates of the program are qualified and prepared to meet the demands of a professional career in the present and future work place and to assume a responsible place of leadership in a complex technological society.

Program Educational Objectives

The engineering program has a mechanism in place to periodically assess its effectiveness in meeting its educational objectives and outcomes (see below). This assessment process results in periodic modification to specific courses and the overall degree plan so as to better promote the achievement of the objectives and outcomes. Additionally, the objectives and outcomes are periodically formulated and revised, with the assistance of the Engineering Advisory Council, in relation to the evolving mission and resource base of the program. This occurs within the context of the evolving needs of the region and nation, and the current state-of-the profession. The specific educational objectives of the degree program are:

- Graduates meet or exceed the expectations of employers of engineering physics majors.
- Qualified graduates will pursue advanced studies, if desired.

The engineering program's outcomes define the knowledge, skills, attitudes, and behaviors that program graduates are expected to have by the time of graduation from the program. Graduates of the engineering program will have:

- An ability to apply knowledge of mathematics, science, and engineering.
- An ability to design and conduct experiments, as well as to analyze and interpret data.
- An ability to design a system, component, or process to meet desired needs with realistic constraints such as economic, environmental, social, political, ethical, health & safety, manufacturability, and sustainability.
- An ability to function in multidisciplinary teams.
- An ability to identify, formulate, and solve engineering and physics problems.
- An understanding of professional and ethical responsibility.
- An ability to communicate effectively.
- A broad education necessary to understand the impact of engineering and physics solutions in a global, economic, environmental, and societal context.
- A recognition of the need for and an ability to engage in life-long learning.
- A knowledge of contemporary issues.
- An ability to use the techniques, skills, and modern engineering tools.

Major Requirement for the Bachelor of Science Degree in Engineering

EGR 1413 Engineering Graphics 3
EGR 2033 Mechanics of Materials 3
EGR 2253 Engineering Computation 3
EGR 2363 Statics 3
EGR 2584 Electric Circuits I 4
EGR 3043 Engineering Thermodynamics I 3
EGR 3434 Digital Electronics 4
EGR 3474 Electronics I 4
EGR 3493 Dynamics 3
EGR 4443 Embedded Microprocessors 3
EGR 4513 Fluid Mechanics 3
EGR 4523 Engineering Electromagnetics 3
EGR 4543 Engineering Measurements 3

EGR 4263 Engineering Design I 3
EGR 4553 Engineering Design II 3

Choose one of the following

EGR 3114 Strength of Materials 4
EGR 3464 Electric Circuits II 4
EGR 3484 Electronics II 4

Choose one of the following

EGR 3053 Engineering Thermodynamics II 3
EGR 3143 Signals and Systems 3
EGR 3503 Engineering Optics 3
EGR 4123 Heat Transfer 3
EGR 4133 Power Systems 3
EGR 4563 Control Systems 3

Additional Requirements

CHM 1014 University Chemistry I 4
MTH 1294 Calculus I 4
MTH 2044 Calculus II.....4
MTH 3104 Calculus III 4
MTH 4123 Differential Equations.....3
PHY 2234 University Physics I 4
PHY 2244 University Physics II 4
Junior-Senior Physics Elective 6

Bachelor of Science degree in Engineering will have earned enough hours to obtain a minor in physics and will not be required to complete an additional minor.

Engineering Minor Requirements

In addition to the Bachelor of Science degree, the Department also offers a minor in engineering. The curriculum provides the student with a basic foundation of engineering. Physics majors can minor in engineering but no elective can apply to both the major and the minor. In addition to the courses listed below, the awarding of a minor in engineering will require that the student has made a grade of C or better in all courses comprising the 24 credit hours.

PHY 2234 University Physics I 4
PHY 2244 University Physics II 4
EGR 1413 Engineering Graphics 3
EGR 2033 Mechanics of Materials 3
EGR 2363 Statics 3
EGR 3043 Engineering Thermodynamics I 3

Choose one of the following

EGR 2584 Electric Circuits I 4
EGR 3474 Electronics I 4
EGR 3434 Digital Electronics 4

Courses in Engineering

EGR 1011. Engineering Shop. This course provides an introduction to manufacturing processes and their relation to the

design of machine elements. Basic and advanced machine tools operations, press tool operation, metal lathe and welding are studies.

EGR 1201. Introduction to Engineering. This course is designed to introduce the student to the engineering profession, problem solving, engineering design and presentation of technical information. Prerequisite: College Algebra (MTH 1243).

EGR 1413. Engineering Graphics. This course is designed to introduce the student to mechanical drawing employing the conventions of computer-aided drafting and modern engineering graphic principles. Prerequisite: College Algebra (MTH 1243).

EGR 1423. Engineering Modeling Applications. A continuation of EGR 1413 Engineering Graphics, covering 3D CAD features and solid modeling techniques including patterning, configurations, library features, sketch blocks, assemblies of parts, multi-body parts, and 3D printing. Prerequisite:EGR1413

EGR 2033. Mechanics of Materials. This course is an introduction to the concepts of stress, deformation and strain in solid materials. Basic relationships between loads, stresses, and deflections of structural and machine elements such as rods, shafts and beams are developed. The load carrying capacity of these elements under tension, compression, torsion, bending and shear forces are considered. Prerequisite: CHM 1014, PHY 2244

EGR 2101-2. Engineering Internship. This course is designed to give the student practical engineering experience working with a professional engineer in a staff approved industrial setting. This allows the beginning engineer to build a network of contacts and develop a broad range of important skills that cannot be learned in the classroom. Prerequisite: Department approval.

EGR 2253. Engineering Computation. This course is designed to introduce the student to the problems encountered in engineering with analysis and solution of these problems using computational techniques. Prerequisite: MTH 1294, PHY 2234.

EGR 2363. Statics. Principles of vector analysis static equilibrium, analysis of structures, friction, internal forces, center of gravity, moment of inertia, and product of inertia. Prerequisite: PHY 2234, MTH 1294.

EGR 2584. Electric Circuits I. An introduction to circuit theory and electrical devices. Topics include resistive circuits, independent and dependent sources; analysis methods, network theorems; RC and RL first order circuits, and RLC second order circuits. Three (3) hours lecture, two (2) hours laboratory. Prerequisite: PHY 2244

EGR 3043. Engineering Thermodynamics I. An introduction to thermodynamics, including thermodynamic properties of pure substances, heat and work, the first and second laws of thermodynamics, and entropy with applications to power and refrigeration cycles. Prerequisite: PHY 2234, MTH 1294

EGR 3053. Engineering Thermodynamics II. A continuation of EGR 3043. The study of thermodynamics is extended to the investigation of relations for simple substances, non-reacting mixtures, reacting mixtures, chemical reactions and a study of availability analysis. Power and refrigeration cycles are studied in more depth. Prerequisite: EGR 3043

EGR 3114. Strength of Materials. Stress and deformation of members in tension, compression, torsion, and bending, and the design of these members. Columns, statically indeterminate beams, and simple connections. Prerequisite: EGR 2363

EGR 3143. Signals and Systems. Signal representation, including Fourier and Laplace transforms. System definitions and properties, such as linearity, causality, time invariance, and stability. Use of convolution, transfer functions and frequency response to determine system response. Prerequisite: EGR 2253, MTH 4123

EGR 3434. Digital Electronics. Introduction to the analysis and design of digital circuits including: number systems, Boolean algebra, combinational and sequential logic. Upon completion, students should be able to construct, analyze, verify, and troubleshoot digital circuits using appropriate techniques and test equipment. Three (3) hours lecture, two (2) hours laboratory. Prerequisite: PHY 2044 or PHY 2244.

EGR 3464. Electric Circuits II. A study of the principles of DC and AC circuits. Passive linear components including resistor, capacitor, inductor. Basic circuit laws. Thevenin and Norton equivalent circuits. Transient and frequency domain analysis of linear circuits. Power and power transfer in circuits. Impedances and electrical units. Three (3) hours lecture, two (2) hours laboratory. Prerequisite: EGR 2464.

EGR 3474. Electronics I. Theory, analysis, and introductory design of diode, bipolar junction transistor, operational amplifier, and field effect translator devices and circuits. Three (3) hours lecture, two (2) hours laboratory. Prerequisite: EGR 2584

EGR 3484. Electronics II. A continuation of EGR 3474 with emphasis on transistor amplifier design, frequency response, feedback principles, stability, analog integrated circuits, electronics circuit design, and applications. Three (3) hours lecture, two (2) hours laboratory. Prerequisites: EGR 3474

EGR 3493. Dynamics. A continuation of EGR 2363. Study of the problems of unbalanced force systems. Kinematics and kinetics of rigid bodies. Work and energy, impulse and momentum. Prerequisites: EGR 2363, MTH 2044

EGR 3503. Engineering Optics. This course gives an introduction to geometrical optics and physical optics, including interference, diffraction, dispersion, absorption, and polarization of light, as well as optics application and practical otpical solutions. Prerequisites: PHY 2244, MTH 1294

EGR 4123. Heat Transfer. Basic thermal energy transport processes; conduction, convection, and radiation; and the mathematical analysis of systems involving these processes in both steady and time-dependent cases. Prerequisite: EGR 3043, EGR 4513

EGR 4133. Power Systems. Basic concepts of AC systems, single-phase and three-phase networks, electric power generation, transformers, transmission lines, electric machinery and the use of power. Prerequisite: EGR 3464

EGR 4263. Engineering Design I. A study of engineering design and creative engineering problem-solving through design projects, presentations, and activities. Prerequisite: PHY 3434.

EGR 4443. Embedded Microprocessors. A study of the programming, architecture, and interfacing of microprocessors with emphasis on engineering applications. Prerequisite: PHY 3434.

EGR 4513. Fluid Mechanics. A study of the statics and dynamics of incompressible fluids. Major topics include the basic fluid flow concepts of continuity, energy and momentum, dimensional analysis, viscosity, laminar and turbulent flows, and flow in pipes. Prerequisites: EGR 3493, MTH3104

EGR 4523. Engineering Electromagnetics. A study of time invariant electric and magnetic fields in free space and in materials, electrical current flow as a function of electric field, magnetic flux, interaction of magnetic fields with electrical current and voltage, electrical and magnetic potentials, time changing electric and magnetic field, Maxwell's Equations and steady-state behavior of wave on transmission lines. Prerequisites: EGR 2584, MTH 3104.

EGR 4531, 4532, 4533, Independent Research. Independent work in engineering physics under direct supervision of a faculty member. Prerequisite: Departmental Approval.

EGR 4543 Engineering Measurements. This course is an introduction to the principles and applications of measurement methods and instrumentation techniques, as used in various engineering disciplines. Specific devices for measuring such parameters as displacement, force, strain, pressure, flow, temperature, motion, time and frequency are discussed. Prerequisite: Junior Standing.

EGR 4553 Engineering Design II. A continuation of EGR 4263 Engineering Design I, covering individual and/or team design projects that require creative application of engineering and basic science knowledge. Prerequisite: EGR 4263

EGR 4563. Control Systems. Mathematical modeling of dynamic systems, stability analysis, control system architectures and sensor technologies. Time-domain and frequency-domain design of feedback control systems: lead, lag, PID compensators. Special topics in microprocessor implementation. Prerequisite: EGR 3363, EGR 4443

EGR 4571, 4572, 4573. Special Topics in Engineering. This senior level elective is designed for the department to offer courses relevant to an instructor's area of expertise, to offer courses of particular interest to current students, or to address

contemporary topics in engineering not covered elsewhere. May be repeated for up to six hours total, provided topics are different. Course title to appear on transcript.

Bachelor of Science Degree in Physics

The physics program combines formal class work with hands-on laboratory work and independent research to create not just future scientists, but future leaders in the community. Following graduation, students find these skills in demand for careers such as science teaching, technical management, software or hardware engineering. Other physics graduates gain admission to graduate programs and continue their studies in specialized fields such as medical physics, meteorology, astrophysics, engineering or geophysics. Many of our physics majors have gone on to receive a Ph.D. degree in physics. We are lucky to count teachers, engineers, business people, and others among our former students.

Major Requirement for the Bachelor of Science Degree (Classical Physics)

PHY 2234 University Physics I 4
PHY 2244 University Physics II 4
PHY 3083 Mechanics 3
PHY 3103 Modern Physics 3
PHY 3473 Computational Physics 3
PHY 4183 Electrodynamics 3
PHY 4253 Advanced Physics Lab 3
PHY 4273 Quantum Mechanics 3
Junior-Senior Physics or Engineering Electives 12

Major Requirement for the Bachelor of Science Degree (Teacher Licensure in Physics)

PHY 2234 University Physics I 4
PHY 2244 University Physics II 4
PHY 3083 Mechanics 3
PHY 3103 Modern Physics 3
PHS 3154 Physical Science for Teachers.....4
PHY 3464 Electric Circuits 4
PHY 4253 Advanced Physics Lab 3
PHY 4293 Non-Western Cosmology 3
PHS 4953 Special Methods: Physical Science.....3
Junior-Senior Physics or Engineering Electives 6

Physics Minor Requirements

In addition to the Bachelor of Science degree, the Department also offers a minor in physics. The curriculum provides the student with a basic foundation of physics. In addition to the courses listed below, the awarding of a minor in physics will require that the student has made a grade of C or better in all courses comprising the 14 credit hours.

PHY 2034 General Physics I or PHY 2234 University Physics I 4
PHY 2044 General Physics II or PHY 2244 University Physics II 4

In addition to the two courses listed above, students must choose two of the following courses:
PHY 3363, PHY 3053, PHY 3083, PHY 3103, PHY 3173, PHY 3323, PHY 3434, PHY 3464, PHY 3473. PHY 1024 does not count toward the minor.

Courses in Physics

PHY 1024 (PHSC1204). Introduction to Astronomy. A general education course for non-science majors. The methods, history, and philosophy of science are studied in the context of modern astronomy. Ideas are emphasized through periodic planetarium presentations as the course traces human understanding from prehistory to the edges of the known cosmos.

Laboratory activities include outdoor observation sessions. No prerequisites are required.

PHY 2034 (PHYS2014). General Physics I. An introductory course in the fundamental principles of mechanics, heat and sound with an emphasis on problem solving. Three (3) hours lecture, two (2) hours laboratory. Prerequisite: MTH 1243.

PHY 2044 (PHYS2024). General Physics II. A continuation of PHY 2034. Fundamentals of electricity, magnetism and light. Three (3) hours lecture, two (2) hours laboratory. Prerequisite: PHY 2034.

PHY 2234. (PHYS2034) University Physics I. An introductory course in mechanics, heat, and sound intended for students of science and engineering who are taking an introductory calculus course concurrently. Three (3) hours lecture, two (2) hours laboratory. Corequisite: MTH 1294.

PHY 2244 (PHYS2044). University Physics II. A continuation of PHY 2234. An introductory course in electricity, magnetism, and light. Three (3) hours lecture, two (2) hours laboratory. Prerequisites: PHY 2234 or PHY 2034 and MTH 1294.

PHY 2363. Statics. Principles of vector analysis static equilibrium, analysis of structures, friction, internal forces, center of gravity, moment of inertia, and product of inertia. Prerequisite: PHY 2234, MTH 1294.

PHY 3053. (WI) General Astronomy. A study of the solar system, stars, clusters, nebulae, gravitation, instrumentation, and the search for life beyond earth. Includes observation sessions and development of planetarium activities. Prerequisite: PHY 2034 or PHY 2234 or the equivalent.

PHY 3083. Mechanics. Particle dynamics in inertial and accelerated reference frames. Newtons law of gravitation, orbit theory, and elementary rigid body dynamics. Prerequisites: PHY 2234 or PHY 2034, and MTH 1294.

PHY 3103. Modern Physics. An introduction to the topics of modern physics including: relativity, atomic physics, quantum mechanics, condensed matter physics, nuclear physics and elementary particles. Prerequisites: PHY 2244 or PHY 2044 and MTH 1294.

PHY 3103L. Modern Physics Laboratory. Experiments in modern physics. Corequisite: Registration in or completion of PHY 3103.

PHY 3173. Optics. This course gives an introduction to geometrical optics and physical optics, including interference, diffraction, dispersion, absorption, and polarization of light. Prerequisites: PHY 2044 or PHY 2244, and MTH 1294.

PHY 3201. (WI) Laboratory Physics Techniques. Experiments in the principles of physics designed for the junior physics student. Experiments in modern physics, mechanics and optics. Corequisite: Registration in or completion of a 3000 or 4000 level physics course.

PHY 3493. History of Physics. A survey of important developments in the field of physics. The course will explore famous experiments and theories, as well as the physicists who performed and developed them. An emphasis will be placed on the role advances in physics played in events at the time and how history influenced the progress of physics. Prerequisite: PHY 2044 or PHY 2244.

PHY 3233. Geophysics. This course introduces the basic theory of geophysical instrumentation, data collection and reduction, and interpretation. The basic laws of physics are applied to study the internal characteristics of the earth such as geomagnetism, paleomagnetism, geogravity, earth tides, elastic waves, earthquake processes, and radioactivity. Prerequisite: PHY 3083.

PHY 3323. Applied Acoustics. The physical nature of vibration and its relation to music, speech, and hearing. Vibratory sources of sound used in music, mechanics of hearing, electronic recording, reproducing and synthesizing sound. No prerequisites are required.

PHY 3434. Digital Electronics. Introduction to the analysis and design of digital circuits including: number systems, Boolean algebra, combinational and sequential logic. Upon completion, students should be able to construct, analyze, verify, and troubleshoot digital circuits using appropriate techniques and test equipment. Three (3) hours lecture, two (2) hours laboratory. Prerequisite: PHY 2044 or PHY 2244.

PHY 3464. Electric Circuits. A study of the principles of DC and AC circuits. Passive linear components including resistor, capacitor, inductor. Basic circuit laws. Thevenin and Norton equivalent circuits. Three (3) hours lecture, two (2) hours laboratory. Prerequisite: PHY 2044 or PHY 2244.

PHY 3473. Computational Physics. This course gives an introduction to the basic methods to model physical and engineering systems using a programming package such as MATLAB. Basic computational tools and routines, including the ones for differential equations, spectral analysis, and matrix operations, are dealt with through relevant examples, and more advanced topics, such as Monte Carlo simulations and molecular dynamics. Prerequisite: PHY 2244.

PHY 3483. Atomic and Molecular Physics. A study of the structure and interaction of atoms and small molecules. Beginning with the study of the structure of the hydrogen atom and advancing to multi-electron atoms and molecules, the course will also cover the interaction of electrons, ions, and photons with atoms and molecules. Additional topics to be covered include atomic and molecular spectra, particle detection, accelerators, perturbation methods, and scattering theory. Prerequisites: PHY 3103 and PHY 3473.

PHY 4093. Thermal Physics. A unified development of the basic principles of thermodynamics, statistical mechanics and kinetic theory. Prerequisite: PHY 3083.

PHY 4183. Electrodynamics. A study of electrostatics, electric and magnetic properties of materials. Amperes and Faradays laws, and Maxwell's equations. Prerequisite: PHY 3083.

PHY 4211-3. Independent Research. Independent work in physics under direct supervision of a faculty member. Prerequisite: Departmental approval.

PHY 4253. (WI) Advanced Physics Lab. Experiments in mechanics, electrodynamics, modern physics and optics using modern instrumentation and equipment. Corequisite: Registration in or completion of a 3000 or 4000 level physics course.

PHY 4273. Introduction to Quantum Mechanics. Solutions of the Schrodinger wave equation, including the infinite square well, finite square well, harmonic oscillator, the hydrogen atom, and perturbation theory, and associated topics. **Prerequisite: PHY 3103.**

PHY 4283. Advanced Mechanics. A continuation of PHY 3083. Rigid bodies; moving coordinate systems; continuous media; Lagrange's Equations. Prerequisites: PHY 3083

PHY 4293. Non-Western Cosmology. This course develops insight into how the cosmological world-view affects and reflects aesthetics, morality, religion, politics, sexuality and other aspects of human experience. People of every culture view the same sky and extrapolate these observations into a story that explains their place in the cosmos. Case studies include native American, ancient non-Western, medieval and Islamic cosmologies. Prerequisite: PHY 1024 or instructor permission.

PHY 4311-3. (WI) Independent Study. Independent work in physics under direct supervision of a faculty member. Prerequisite: Departmental approval.

PHY 4343. Astrophysics and Cosmology. A unified study of relationships between natural physical laws and the structure and evolution of the cosmos. The course surveys recent results from observational astronomy and related applications of quantum theory, nuclear physics, field theory, particle physics, and general relativity. Prerequisites: PHY 3083 and PHY 3103.

PHY 4443. Embedded Microprocessors. A study of the programming, architecture, and interfacing of microprocessors with emphasis on engineering applications. Prerequisite: PHY 3434.

PHY 4453. Signal Processing. Introduction to the fundamental concepts and mathematics in signal processing. Use of the fundamental transform techniques (Laplace transform, discrete Fourier transform, z-transform). Discrete time representation of signals, linear time invariant systems. Correlation, coherence, power spectral density, and time delays. Bode plots, poles and zeros, state space. Prerequisite: 3473.

PHY 4571, 4572, 4573. Special Topics in Physics. This senior level elective is designed for the department to offer

courses relevant to an instructor's area of expertise, to offer courses of particular interest to current students, or to address contemporary topics in physics not covered elsewhere. May be repeated for up to six hours total, provided topics are different. Course title to appear on transcript.

PHYSICAL SCIENCE
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Courses in Physical Science

PHS 1053. Earth Systems and the Environment. A study of the earth and earth history, emphasizing interrelationships between earth's dynamical systems and human activity. Course activities include periodic field experiences and planetarium presentations. No prerequisites are required.

PHS 1073. Meteorology. An introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small-and large-scale motions, air masses, fronts, tropical cyclones, solar and terrestrial radiation, general circulation and weather forecasting. Format may include field trips and guest lectures. No prerequisites are required.

PHS 1133. Introduction to Physical Geology. An examination of the basic concepts of physical geology, stratigraphy, mineralogy, and land forms.

PHS 3154/PHS 3154L. Physical Science for Teachers. A study of the principles and concepts of physical science designed for elementary teachers. Three (3) hours lecture, two (2) hours laboratory

PHS 4183, 5183. Higher Order Thinking in Science. This laboratory-based course stresses the learning of science as active, integrated, constructive processes involving experimentation, investigation, communication, reasoning and problem solving. The course builds foundations in content to show connections and relevant applications in the areas of life systems, earth systems, and physical systems. The goals of the course are to help teachers extend content learning, to help teachers create successful learning environments for every student by teaching them to use manipulatives, calculators, science equipment, and various learning strategies, and to provide access to appropriate materials, equipment and technology.

PHS 4953. Special Methods: Physical Science. Special methods in the teaching of physical science.