EN.615 (APPLIED PHYSICS)

Courses

EN.615.611. Classical Physics. 3 Credits.
This course provides the graduate student in Applied Physics with a review of the basic core topics in classical physics, presented at an entry graduate level. The basic subfields covered are classical mechanics (including fluids and acoustics), thermal (and statistical) physics, electromagnetism (including plasmas and relativity), and optics. The four major core topics (in italics) are treated in roughly equal depth. For each topic covered, the fundamental physical laws are introduced to establish a rigorous but intuitive understanding of the basic physics, which is reinforced with hands-on demonstrations and relevant homework assignments. A final exam will also cover the core concepts and principles to check the student's understanding of the key concepts presented. In addition, each student will delve into one subtopic of their own choosing, according to their interest and needs, treating it in more depth as an extended homework assignment, which will be submitted in written form and given as a brief oral presentation before the end of the semester. This course will complement the modern physics course as well as the advanced mathematical methods course offered in the Applied Physics program. Prerequisite(s): An undergraduate degree in physics, engineering, or a related field.

EN.615.621. Electric Power Principles. 3 Credits.
This is an introductory course on electric power, its distribution, and its applications. The first half of the course focuses on the physics of electric power and its generation, with an emphasis on distribution and distribution systems. Topics to be covered include AC voltages and currents, transmission lines, mono- and poly-phase systems, and losses due to electromagnetic forces. The second half of the course is directed toward applications. Specific applications covered include system analysis and protection, power electronics, induction and permanent magnet motors, transformers, etc. At least one lecture will be used to bring all the concepts together by studying the implementation of an alternative power generation system using wind turbines. During the course of the term, several research papers on power generation and distribution will be read and summarized by the students. A term paper on an electric power subject may be required. Prerequisite(s): An undergraduate degree in physics, engineering, or a related field.

EN.615.641. Mathematical Methods for Physics and Engineering. 3 Credits.
This course covers a broad spectrum of mathematical techniques essential to the solution of advanced problems in physics and engineering. Topics include ordinary and partial differential equations, contour integration, tabulated integrals, saddlepoint methods, linear vector spaces, boundary-value problems, eigenvalue problems, Green's functions, integral transforms, and special functions. Application of these topics to the solution of problems in physics and engineering is stressed. Prerequisite(s): Vector analysis and ordinary differential equations (linear algebra and complex variables recommended).

EN.615.642. Electromagnetics. 3 Credits.
Maxwell's equations are derived and applied to the study of topics including electrostatics, magnetostatics, propagation of electromagnetic waves in vacuum and matter, antennas, wave guides and cavities, microwave networks, electromagnetic waves in plasmas, and electric and magnetic properties of materials. Prerequisite(s): Knowledge of vector analysis, partial differential equations, Fourier analysis, and intermediate electromagnetics.

EN.615.647. Fundamentals of Sensors. 3 Credits.
Students will receive an overview of sensors and methods to build networks and systems using sensors. The physics of detectors including fundamental technologies and sampling interfaces will be discussed. Sensor technologies for chemical, biological, nuclear, and radiological detection will be studied in detail. Evaluation methods will be presented for sensor selection based on application-specific information including sensor performance, environmental conditions, and operational impact. DODAF 2.0 methods will be taught and a project based on several viewpoints will be required and presented. Additional studies will include methods for combining results from various sensors to increase detection confidence. As part of the course, students will be given a threat scenario and will be required to select a sensor suite and networking information to design a hypothetical system considering the threat, sensor deployment cost, and logistics. Prerequisite(s): An undergraduate degree in engineering, physics, or a related technical discipline.

EN.615.648. Alternate Energy Technology. 3 Credits.
Energy availability and its cost are major concerns to every person. Fossil fuels in general and oil in particular are limited and the world's reserves are depleting. The question asked by many is, "Are there alternatives to the fossil fuel spiral (dwindling supplies and rising costs)?" This course addresses these alternative energy sources. It focuses on the technology basis of these alternate energy methods, as well as the practicality and the potential for widespread use and economic effectiveness. Energy technologies to be considered include photovoltaics, solar thermal, wind energy, geothermal and thermal gradient sources, biomass and synthetic fuels, hydroelectric, wave and tidal energy, and nuclear. The associated methods of energy storage will also be discussed. Prerequisite(s): An undergraduate degree in engineering, physics, or a related technical discipline.

EN.615.651. Statistical Mechanics and Thermodynamics. 3 Credits.
After a brief historical review of thermodynamics and statistical mechanics, the basic principles of statistical mechanics are presented. The classical and quantum mechanical partition functions are discussed and are subsequently used to carry out derivations of the basic thermodynamic properties of several different systems. Topics discussed include Planck's black body radiation derivation and the Einstein-Debye theories of the specific heats of solids. The importance of these topics in the development and confirmation of quantum mechanics is also examined. Other topics discussed include Fermi Dirac and the Bose-Einstein statistics and the cosmic background radiation. The importance of comparisons between theory and data is stressed throughout.

EN.615.653. Classical Mechanics. 3 Credits.
This is an advanced course in classical mechanics that introduces techniques that are applicable to contemporary pure and applied research. The material covered provides a basis for a fundamental understanding of not only quantum and statistical mechanics but also nonlinear mechanical systems. Topics include the Lagrangian and Hamiltonian formulation of classical mechanics, Euler's rigid body equations of motion, Hamilton-Jacobi theory, and canonical perturbation theory. These methods are applied to force-free motion of a rigid body, oscillations of systems of coupled particles, and central force motion including the Kepler problem and scattering in a Coulomb potential. Applications are emphasized through in-class examples and homework. **Prerequisite(s):** Intermediate mechanics and EN.615.641 Mathematical Methods for Physics and Engineering.

EN.615.654. Quantum Mechanics. 3 Credits.
This course presents the basic concepts and mathematical formalism of quantum mechanics. Topics include the mathematics of quantum mechanics, the harmonic oscillator and operator methods, quantum mechanics in three dimensions and angular momentum, quantum mechanical spin, quantum statistical mechanics, approximation methods, and quantum theory of scattering.
Prerequisite(s): Undergraduate courses in differential equations, multi-variable calculus, linear algebra, and complex variable theory or EN.615.641 Mathematical Methods for Physics and Engineering or the equivalent.AND EN.615.653 Classical Mechanics

EN.615.655. Orbital and Celestial Mechanics. 3 Credits.
This course will focus on the study of orbital and celestial mechanics, using many of the methods that are covered in a traditional advanced mechanics course. We will look primarily at closed form and approximation methods (as opposed to numerical solutions) in a wide variety of problems in orbital and celestial mechanics. Space engineering and applied physics students who take this class will be well-versed in fundamentals that can then be leveraged in more advanced future space applications. Topics will include Newtonian Mechanics, Newtonian Gravitation, Central Force Orbits (with a focus on Keplerian Orbits), Orbital & Interplanetary Maneuvers, Non-inertial Reference Frames, the Lagrangian Formalism, Rigid Body Rotation, the Three Body Problem, Approximation Methods for Orbits, and Lunar Motion. Discussions will include the historical figures in physics who contributed significantly to the topics discussed.
Prerequisite(s): EN.615.641 Mathematical Methods for Physics and Engineering or EN.675.650 Mathematics for Space Systems

EN.615.661. Introduction to Planetary Science. 3 Credits.
This course introduces students to the field of planetary space science, including the study of planets, moons, comets, asteroids.

EN.615.662. Introduction to Astrophysics. 3 Credits.
In this course we explore the properties of stellar interiors in order to understand stellar structure and evolution. Our emphasis will be on the fundamental physics of matter and radiation at high pressure and temperature. Topics will include star formation by gravitational collapse, thermodynamics of matter and radiation, hydrostatic equilibrium, radiative and convective heat transport, energy production in stars (burning of Hydrogen, Helium, and advanced burning), endpoints of stellar evolution (white dwarfs, neutron stars, and black holes). Familiarity with multi-variable calculus, classical mechanics, thermodynamics, statistical mechanics, and quantum mechanics at the undergraduate level is required.
Prerequisite(s): Undergraduate courses in statistical mechanics, quantum mechanics, multivariable calculus, and differential equations,Or EN.615.651 Statistical Mechanics OR EN.615.654 Quantum Mechanics.

EN.615.663. Physics in Lunar Exploration. 3 Credits.
This course introduces students to lunar exploration, one of the highest priority goals of the international space community. The course will include early exploration Apollo, samples, science from orbit, lunar volatiles, and future goals through exploration.

EN.615.664. Introduction to Exoplanets. 3 Credits.
This course will introduce students to one of the hottest field in all of space science, the discovery and characterization of exoplanets. These planets beyond our Solar System are found in nearly all stellar systems. Modern tools including space and ground-based observations are providing an unprecedented characterization of exoplanets including measuring the composition of their atmospheres.

EN.615.665. Modern Physics. 3 Credits.
This course covers a broad spectrum of topics related to the development of quantum and relativity theories. The understanding of modern physics and its applications is essential to the pursuit of advanced work in materials, optics, and other applied sciences. Topics include the special theory of relativity, particle-like properties of light, wave-like properties of particles, wave mechanics, atomic and nuclear phenomena, elementary particles, statistical physics, solid state, astrophysics, and general relativity.Prerequisite(s): Undergraduate degree in physics or engineering.

EN.615.671. Principles Of Optics. 3 Credits.
This course teaches the student the fundamental principles of geometrical optics, radiometry, vision, and imaging and spectroscopic instruments. It begins with a review of basic, Gaussian optics to prepare the student for advanced concepts. From Gaussian optics, the course leads the students through the principles of paraxial ray-trace analysis to develop a detailed understanding of the properties of an optical system. The causes and techniques for the correction of aberrations are studied. The course covers the design principles of optical Instruments, telescopes, microscopes, etc. The techniques of light measurement are covered in sessions on radiometry and photometry. Prerequisite(s): Undergraduate degree in physics or engineering.

EN.615.680. Materials Science. 3 Credits.
This course covers a broad spectrum of materials-related topics designed to prepare the student for advanced study in the materials arena. Topics include atomic structure, atom and ionic behavior, defects, crystal mechanics, strength of materials, material properties, fracture mechanics and fatigue, phase diagrams and phase transformations, alloys, ceramics, polymers, and composites. Prerequisite(s): An undergraduate degree in engineering, physics, or a related technical discipline.

EN.615.682. Materials Characterization. 3 Credits.

EN.615.683. Materials in Extreme Environments. 3 Credits.
Why can the nuclear fuel cladding in a fission reactor cause an explosion in the core? If SiC vaporizes in a gas-turbine environment, why have SiC ceramic matrix composites become standard in aerospace engines? Why do all materials seemingly vaporize in the cold vacuum of very low earth orbit? Why is the precious metal iridium an excellent material for both jewelry and hypersonics? How can cork keep astronauts comfortable during atmospheric re-entry? This course will teach students fundamental material degradation mechanisms that drive materials selection and material failure in extreme environments, such as oxidation, creep, fatigue, embrittlement, interdiffusion, thermal cycling and coefficient of thermal expansion mismatch, stability under fission and fusion irradiation. A thorough understanding of various extreme environments will be gained and used to understand legacy and recent advanced materials selection for a variety of applications, such as industrial and aerospace gas turbines, nuclear fission and fusion reactors, very low earth orbit, hypersonics, and re-entry. Specific material systems to be covered are Ni-base superalloys, oxidation resistant overlay coatings, thermal barrier coatings, SiC ceramic matrix composites, environmental barrier coatings, accident tolerant fuel cladding, atomic oxygen resistant polymers, thermal protection systems, and ultrahigh temperature ceramics.

EN.615.715. Applied Atomic and Molecular Physics. 3 Credits.

EN.615.731. Photovoltaic & Solar Thermal Energy Conversion. 3 Credits.
This is an advanced course in the application of science and technology to the field of solar energy in general and photovoltaic and solar thermal energy systems in particular. The foundations of solar energy are described in detail to provide the student with the knowledge to evaluate and/or design complete solar thermal or photovoltaic energy systems. Topics range from the theoretical physical basics of solar radiation to the advanced design of both photovoltaic and solar thermal energy collectors. A major feature of the course is the understanding and design of semiconducting photovoltaic devices (solar cells). Solar cell topics include semiconductors, analysis of p-n junction, Shockley-Queisser limit, non-radiative recombination processes, antireflection coating, crystalline silicon solar cells, thin-film solar cells, and rechargeable batteries. Solar thermal energy topics include solar heat collectors, solar water heaters, solar power systems, sensible heat energy storage, phase transition thermal storage, etc. The course will also present optimizing building designs for a solar energy system. Prerequisite(s): An undergraduate degree in engineering, physics, or a related technical discipline.

EN.615.744. Physics of Space Systems I. 3 Credits.
This is the first course in a two-course series (second course is 615.745) where students learn the fundamentals of designing space systems. The focus is on the underlying physics of major spacecraft subsystems, orbits, and launch vehicles. In this first course, topics include an overview of space systems engineering, the space environment, astrodynamics, space communications, orbit determination, propulsion, and spacecraft attitude determination and control. Concepts are introduced through lectures and then reinforced through homework assignments that include modeling, simulation, and analysis using MATLAB.Prerequisites: College courses in physics, calculus, and linear algebra.

EN.615.745. Physics of Space Systems II. 3 Credits.
This course examines the fundamentals necessary to design and develop space experiments and space systems. The course presents the theoretical background, current state of the art, and examples of the disciplines essential to developing space instrumentation and systems. Experts in the field will cover the following topics: spacecraft attitude determination and control, space communications, satellite command and telemetry systems, satellite data processing and storage, and space systems integration and testing. This course requires the completion of a research paper. Prerequisite(s): An undergraduate degree in physics or engineering or the equivalent. Although preferable, it is not necessary to have taken EN.615.744 Physics of Space Systems I

EN.615.747. Sensors and Sensor Systems. 3 Credits.
The primary objective of this course is to present recent advances made in the field of sensors. A broad overview includes optical, infrared, hyperspectral, terahertz, biological, magnetic, chemical, acoustic, and radiation sensors. The course will examine basic sensor operation and the implementation of sensors in measurement systems. Other topics to be covered are physical principles of sensing, interface electronic circuits, and sensor characteristics. Prerequisite(s): An undergraduate degree in engineering, physics, or a related technical discipline.

EN.615.748. Introduction to Relativity. 3 Credits.
After a brief review of the theory of special relativity, the mathematical tools of tensor calculus that are necessary for understanding the theory of general relativity will be developed. Relativistic perfect fluids and their stress-energymomentum tensor will be defined, and Einstein's field equations will be studied. Gravitational collapse will be introduced, and the Schwarzschild Black Hole solution will be discussed.
Prerequisite(s): EN.615.653 Classical Mechanics.AND either: undergraduate courses in differential equations, multi-variablecalculus, linear algebra,Or: EN.615.641 Mathematical method for physics and engineering.

EN.615.751. Modern Optics. 3 Credits.
This course covers the fundamental principles of modern physical optics and contemporary optical systems. Topics include propagation of light, polarization, coherence, interference, diffraction, Fourier optics, absorption, scattering, dispersion, and image quality analysis. Special emphasis is placed on the instrumentation and experimental techniques used in optical studies.
Prerequisite(s): EN.615.642 Electromagnetics or the equivalent completed or taken concurrently.

EN.615.753. Plasma Physics. 3 Credits.
This course is an introduction to the physical processes that govern the "fourth state of matter", also known as plasma. Plasma physics is the study of ionized gas, which is the state of the matter for 99.9% of the apparent universe, from astrophysical plasmas, to the solar wind and Earth's radiation belts and ionosphere. Plasma phenomena are also relevant to energy generation by controlled thermonuclear fusion. The challenge of plasma physics comes from the fact that many plasma properties result from the long-range Coulomb interaction, and therefore are collective properties that involve many particles simultaneously. Topics to be covered during class include motion of charged particles in electric and magnetic fields, dynamics of fully ionized plasma from both microscopic and macroscopic points of view, magneto-hydrodynamics, equilibria, waves, instabilities, applications to fusion devices, ionospheric, and space physics. .
Prerequisite(s): EN.615.642 Electromagnetics or the equivalent

EN.615.755. Space Physics. 3 Credits.
This course studies the physics and the history of our utilization of space, the challenges and mitigation of making in situ observations in space. Topics include the history of solar system exploration; the solar cycle; the electrodynamics of the solar upper atmosphere responsible for the solar wind; and the solar wind interaction with unmagnetized and magnetized bodies—how this leads to planetary bow shocks, comets, and magnetospheres and how they are studied. Practical issues include penetrating radiation and its effects on spacecraft and man in space, magnetospheric storm disruptions of ground power distribution and spacecraft charging in the presence and absence of solar illumination with particular reference to applying this knowledge in exploring the outer solar system and beyond.
Prerequisite(s): EN.615.642 Electromagnetics or the equivalent.

EN.615.757. Solid State Physics. 3 Credits.
Students examine concepts and methods employed in condensed matter physics with applications in materials science, surface physics, and electronic devices. Topics include atomic and electronic structure of crystalline solids and their role in determining the elastic, transport, and magnetic properties of metals, semiconductors, and insulators. The effects of structural and chemical disorder on these properties are also discussed.
Prerequisite(s): EN.615.654 Quantum Mechanics or the equivalent.

EN.615.761. Intro To Oceanography. 3 Credits.
This course covers the physical concepts and mathematics of the exciting field of oceanography and can be taken as an elective. It is designed for the student who wants to learn more about oceanography. Topics range from fundamental small waves to planetary-scale ocean currents. There will be a strong emphasis on understanding the basic ocean processes. Initial development gives a description of how the ocean system works and the basic governing equations. Additional subjects include boundary layers, flow around objects (seamounts), waves, tides, Ekman flow, and the Gulf Stream. Also studied will be the ocean processes that impact our climate such as El Nino and the Thermohaline Conveyor Belt. Prerequisite(s): Mathematics through calculus.

EN.615.762. Applied Computational Electromagnetics. 3 Credits.
This course introduces the numerical methods and computer tools required for the practical applications of the electromagnetic concepts covered in EN.615.642 to daily-life engineering problems. It covers the methods of calculating electromagnetic scattering from complex air and sea targets (aircraft, missiles, ships, etc.), taking into account the effects of the intervening atmosphere and natural surfaces such as the sea surface and terrain. These methods have direct applications in the areas of radar imaging, communications, and remote sensing. Methods for modeling and calculating long-distance propagation over terrain and in urban areas, which find application in the areas of radar imaging, radio and TV broadcasting, and cellular communications, are also discussed. The numerical toolkit built in this course includes the method of moments, the finite difference frequency and time domain methods, the finite element method, marching numerical methods, iterative methods, and the shooting and bouncing ray method. Prerequisite(s): Knowledge of vector analysis, partial differential equations, Fourier analysis, basic electromagnetics, and a scientific computer language.

EN.615.763. Infrared Sensors: Physics and Applications. 3 Credits.
In this course the physics behind the operation of modern infrared (IR) detectors and sensors systems will be elucidated. This will include not only the physics and technology behind the detectors themselves but also the associated technologies such as optics, coolers and readout integrated circuits (ROICs). The course will begin with a history of the development of IR detectors. Next basic concepts needed to describe the performance of the detectors and sensor systems will be described and finally there will be examples of applications to modern IR sensor systems used in the ground, airborne and space domains.

EN.615.765. Chaos and Its Applications. 3 Credits.
The course will introduce students to the basic concepts of nonlinear physics, dynamical system theory, and chaos. These concepts will be studied by examining the behavior of fundamental model systems that are modeled by ordinary differential equations and, sometimes, discrete maps. Examples will be drawn from physics, chemistry, and engineering. Some mathematical theory is necessary to develop the material. Practice through concrete examples will help to develop the geometric intuition necessary for work on nonlinear systems. Students conduct numerical experiments using provided software, which allows for interactive learning. Prerequisite(s): Mathematics through ordinary differential equations. Familiarity with MATLAB is helpful. Consult instructor for more information.

EN.615.769. Physics of Remote Sensing. 3 Credits.
This course exposes the student to the physical principles underlying satellite observations of Earth by optical, infrared, and microwave sensors, as well as techniques for extracting geophysical information from remote sensor observations. Topics will include spacecraft orbit considerations, fundamental concepts of radiometry, electromagnetic wave interactions with land and ocean surfaces and Earth's atmosphere, radiative transfer and atmospheric effects, and overviews of some important satellite sensors and observations. Examples from selected sensors will be used to illustrate the information extraction process and applications of the data for environmental monitoring, oceanography, meteorology, and climate studies.

EN.615.772. Cosmology. 3 Credits.
This course begins with a brief review of tensor calculus and principles of the General theory of relativity, the Freidmann equation and the Robertson-Walker metric. Cosmological models including radiation, matter, and the cosmological constant and their properties are discussed. Observational parameters, the role of dark matter, and the cosmic microwave background, and nucleosynthesis in the early universe are studied. The flatness and the horizon problems are introduced and the role of inflation in the early universe is discussed. Finally, we discuss the origins and the role of density fluctuations in formation of large structures leading to the current Cosmological constant Cold Dark Matter model of the universe.
Prerequisite(s): EN.615.748 Introduction to Relativity.

EN.615.775. Physics of Climate. 3 Credits.
To understand the forces that cause global climate variability, we must understand the natural forces that drive our weather and our oceans. This course covers the fundamental science underlying the nature of the Earth's atmosphere and its ocean. This includes development of the basic equations for the atmosphere and ocean, the global radiation balance, description of oceanic and atmospheric processes, and their interactions and variability. Also included will be a description of observational systems used for climate studies and monitoring, fundamentals underlying global circulation, and climate prediction models. Prerequisite(s): Undergraduate degree in physics or engineering or equivalent, with strong background in mathematics through the calculus level.

EN.615.776. Quantum Algorithms: Near Term Applications. 3 Credits.
This course will dive into NISQ algorithms and their implementation on currently available quantum processors. It will begin with an overview of quantum circuits and the IBM Qiskit API, a popular tool for constructing, simulating, and experimentally executing quantum circuits. After briefly discussing the current limitations of NISQ devices, we will begin exploring NISQ era quantum algorithms. First, we will discuss variational quantum algorithms, a hybrid quantum-classical approach ubiquitously used in modern quantum computing. We will cover applications for solving classical optimization problems on quantum hardware and finding ground states of molecular systems. Finally, we will focus on the use of quantum processors for the simulation of time dynamics of quantum systems.

EN.615.778. Optical System Design and Modelling. 3 Credits.
In this course, students learn to design optical systems and model their performance. Students will use commercially available optical design software to complete their assignments and their design project. We will begin with simple lenses for familiarization with optical design software using CODE V, and then move onto more complicated multi-element lenses and reflective systems. For their design project, students may use any software of their choosing (e.g. OSLO, ZEMAX, OpTalix, SYNOPSYS, their own, etc.). Emphasis is placed on understanding the optical concepts involved in the designs while developing the ability to use design software to properly model optical systems. Upon completion of the course, students are capable of independently pursuing their own optical designs and building optical models of existing systems.
Prerequisite(s): EN.615.671 Principles of Optics

EN.615.780. Optical Detectors & Applications. 3 Credits.
This course examines the physics of detection of incoherent electromagnetic radiation from the infrared to the soft X-ray regions. Brief descriptions of the fundamental mechanisms of device operation are given. A variety of illumination sources are considered to clarify detection requirements, with emphasis on solar illumination in the visible and blackbody emission in the infrared. Practical devices, elementary detection circuits, and practical operational constraints are described. An introduction to solid-state and semiconductor physics follows and is then applied to the photodiode, and later to CCD and CMOS devices. A description and analysis of the electronics associated with photodiodes and their associated noise is given. Description of scanning formats leads into the description of spatially resolving systems (e.g., staring arrays). Emphasis is placed on Charged-Coupled Device and CMOS detector arrays. This naturally leads into the discussion of more complex IR detectors and Readout Integrated Circuits that are based on the CMOS pixel. In addition, descriptions of non-spatially resolving detectors based on photoemission and photo-excitation are provided, including background physics, noise, and sensitivity. Selection of optimum detectors and integration into complete system designs are discussed. Applications in space-based and terrestrial remote sensing are discussed, from simple radiometry and imaging to spectrometry. Prerequisite(s): Undergraduate degree in physics or engineering, preferably with studies in elementary circuit theory, solid-state physics, and optics. Students are expected to be proficient using spreadsheets and/or a programming language such as MATLAB or IDL.

EN.615.781. Quantum Information Processing. 3 Credits.
This course provides an introduction to the rapidly developing field of quantum information processing. In addition to covering fundamental concepts such as two-state systems, measurements uncertainty, quantum entanglement, and nonlocality, the course will emphasize specific quantum information protocols. Several applications of this technology will be explored, including cryptography, teleportation, dense coding, computing, and error correction. The quantum mechanics of polarized light will be used to provide a physical context to the discussion. Current research on implementations of these ideas will also be discussed.
Prerequisite(s): EN.615.654 Quantum Mechanics

EN.615.782. Optics and Matlab. 3 Credits.
This course provides hands-on experience with MATLAB by performing weekly computer exercises revolving around optics. Each module explores a new topic in optics, while simultaneously providing experience in MATLAB. The goal is to bridge the gap between theoretical concepts and real-world applications. Topics include an introduction to MATLAB, review of electromagnetism, ray tracing, 1D Fourier theory and propagation in optical fibers, laser beam propagation, paraxial wave propagation in turbulent media, diffraction and holography, polarization and interferometry, optical waveguides and laser theory and related technologies. Students are expected to complete a semester project that will facilitate investigation of a topic of interest not specifically covered in the course. Course Note(s): No prior experience with MATLAB is required. While a background in optics is helpful, it is not required.

EN.615.783. Quantum Instrumentation. 3 Credits.

EN.615.784. Superconducting Devices: Physics and Applications. 3 Credits.
Physics of Superconducting Devices: This course will cover the basics of superconductivity and its applications in quantum computing. We will discuss the physics of Josephson junctions and how they are used to build quantum bits (qubits). We will then study two currently popular superconducting qubits: the transmon and the fluxonium. We will also look at superconducting amplifiers, including Travelling Wave Parametric Amplifiers (TWPAs). Lastly, we will explore how these devices, including magnetometers, may be used for quantum sensing.

EN.615.800. Applied Physics Project. 3 Credits.
This course is an individually tailored, supervised project that offers the student research experience through work on a special problem related to his or her field of interest. The research problem can be addressed experimentally or analytically, and a written report is produced. It is recommended that all required Applied Physics courses be completed. Open only to candidates in the Master of Science in Applied Physics program. Prerequisite(s): It is recommended that all required Applied Physics courses be completed. The Independent Study/Project proposal form (https://ep.jhu.edu/current-students/student-forms/) must be approved prior to registration. Course Note(s): Open only to candidates in the Master of Science in Applied Physics program.

EN.615.802. Directed Studies in Applied Physics. 3 Credits.
In this course, qualified students are permitted to investigate possible research fields or to pursue problems of interest through reading or non-laboratory study under the direction of faculty members. Open only to candidates in the Master of Science in Applied Physics program. Prerequisite(s): The Independent Study/Project proposal form (https://ep.jhu.edu/current-students/student-forms/) must be completed and approved prior to registration. Course Note(s): Open only to candidates in the Master of Science in Applied Physics program.