Engineering & Physics

The purpose of the Whitworth University Department of Engineering & Physics is to provide our students with an academically rigorous education in physics and engineering. This education takes place in a context of committed Christian faith, intellectual challenge and holistic mentoring. Through a foundation in physics and engineering as well as professional communication and ethics, we prepare students for lives of meaningful work in which they will explore the laws of the natural world that God has made and will design solutions to meet the needs of humanity.

Engineering

Program Educational Objectives

The B.S. in engineering from Whitworth University is designed to prepare our graduates for professional practice or advanced studies by providing a broad education in engineering fundamentals in a liberal arts environment. The objectives of the program are that recent graduates will...

1. be active in engineering practice or apply their engineering background and problem-solving skills in fields outside engineering.
2. increase their capacity to serve their profession, their community and the world by building on the foundational knowledge, skills and values gained at Whitworth.
3. help meet the needs of humanity as professionals who exhibit high ethical and professional standards.
4. communicate truthfully and effectively with various audiences on both technical and non-technical topics.
5. serve their profession, the community and God's creation.

Student Outcomes

Upon graduation, Whitworth University engineering majors will be able to demonstrate...

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.
2. an ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, as well as global, cultural, social, environmental and economic factors.
3. an ability to communicate truthfully and effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts as informed by Christian and other applicable perspectives.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
8. An ability to articulate how their values and beliefs are connected to their vocation.

Physics

Student Outcomes

Upon graduation, Whitworth University physics majors will be able to demonstrate...

1. knowledge of physics.
2. the ability to design and conduct experiments, as well as to analyze and interpret data.
3. the ability to develop appropriate computational tools for the practice of physics.
4. an ability to articulate how their values and beliefs are connected to their vocation.
5. the ability to communicate truthfully and effectively.
6. the knowledge, experience and attitude to enhance their capabilities and adapt continuously to a changing world.

7. the knowledge and habits required to continue with successful advanced study in physics or related fields.
8. significant experience conducting original research in basic or applied science.

Important note:

Completion of PS 151 and PS 153 with at least a 2.7 GPA is required for enrollment in all courses numbered above 220 in the department. Students with a GPA between 2.3 and 2.7 in those two courses are eligible to file a petition with the chair of the Whitworth Department of Engineering & Physics for a provisional exemption to enroll in further courses.

Requirements for a Physics Major, B.A. (46)

PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
One of the following:		1
PS 153L	General Physics II Lab	
PS 154L	Near Space Research Project	
PS 251W	Modern Physics	4
MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 281	Differential Equations	3
CH 161	General Chemistry I	3
CH 161L	General Chemistry I Lab	1
15 credits from the following:		15
PS 351	Dynamics	
PS 353	Advanced Dynamics	
PS 361	Nuclear Physics	
PS 363	Thermal Physics	
PS 371	Optics	
PS 451	Electricity and Magnetism I	
PS 453	Electricity and Magnetism II	
PS 455	Quantum Mechanics	
EN 271	Computational Methods	
EN 356	Mathematical Methods I	
EN 358	Mathematical Methods II	
For 4-12 teaching endorsement, the following additional courses are required: All endorsements subject to change; see School of Education for updated requirements.		
MA 256	Elementary Probability and Statistics	
EDU 455W	Science in Secondary School	
EN 121	Epic Fails in Engineering	

Requirements for an Applied Physics Major, B.A. (56-58)

EN 130	Introduction to Engineering	2
PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
One of the following:		1
PS 153L	General Physics II Lab	
PS 154L	Near Space Research Project	
PS 251W	Modern Physics	4
MA 171	Calculus I	4

MA 172	Calculus II	4
MA 273	Calculus III	4
MA 281	Differential Equations	3
CH 161	General Chemistry I	3
CH 161L	General Chemistry I Lab	1
CS 171	Computer Science I	3
One of the following:		3
EN 171	Engineering Graphics & CAD	
CS 172	Computer Science II	
CH 181	General Chemistry II	
One of the following:		3
EN 211	Statics	
EN 230	Electric Circuit Analysis	
EN 271	Computational Methods	
EN 173	Introduction to Embedded Systems	
Two of the following:		4-6
EN 356	Mathematical Methods I	
EN 358	Mathematical Methods II	
MA 330	Linear Algebra	
MA 357	Mathematical Statistics I	
Ten (10) additional approved upper-division credits from physics, engineering, computer science, or chemistry with at least three (3) of those credits from physics or engineering		10

Requirements for a Physics Major, B.S. (69)

PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
One of the following:		1
PS 153L	General Physics II Lab	
PS 154L	Near Space Research Project	
PS 251W	Modern Physics	4
PS 351	Dynamics	3
PS 353	Advanced Dynamics	4
PS 363	Thermal Physics	4
PS 451	Electricity and Magnetism I	3
PS 453	Electricity and Magnetism II	4
PS 455	Quantum Mechanics	4
PS 388	Internship Preparation	1
PS 393	Internship Reflection	1
One of the following:		4
PS 361	Nuclear Physics	
PS 371	Optics	
One of the following:		3
CS 171	Computer Science I	
EN 173	Introduction to Embedded Systems	
EN 271	Computational Methods	
MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 281	Differential Equations	3

EN 356	Mathematical Methods I	2
EN 358	Mathematical Methods II	2
CH 161	General Chemistry I	3
CH 161L	General Chemistry I Lab	1
CH 181	General Chemistry II	3

For 4-12 teaching endorsement, the following additional courses are required: All endorsements subject to change; see School of Education for updated requirements.

MA 256	Elementary Probability and Statistics	
EDU 455W	Science in Secondary School	
EN 121	Epic Fails in Engineering	

Requirements for a Biophysics Major, B.S. (66-70)

PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
One of the following:		1
PS 153L	General Physics II Lab	
PS 154L	Near Space Research Project	
PS 251W	Modern Physics	4
PS 363	Thermal Physics	4
MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
CH 161	General Chemistry I	3
CH 161L	General Chemistry I Lab	1
CH 181	General Chemistry II	3
CH 181L	General Chemistry II Lab	1
CH 271	Organic Chemistry I	3
CH 271L	Organic Chemistry I Lab	1
BI 140	General Biology I: Genes, Cells and Evolution	4
BI 143	General Biology II: Ecology and Evolution	4
MA 281	Differential Equations	3
One of the following:		3
BI 311	General Biochemistry	
CH 401	Biochemistry I	
Electives		
Four of the following with at least one from physics and one from biology:		12-16
BI 363	Genetics	
BI 399	Molecular Genetics	
BI 404	Neurophysiology	
BI 412	Cell Physiology	
CH 278	Organic Chemistry II	
CH 403	Biochemistry II	
EN 230	Electric Circuit Analysis	
EN 271	Computational Methods	
PS 351	Dynamics	
PS 361	Nuclear Physics	
PS 371	Optics	
PS 451	Electricity and Magnetism I	
PS 455	Quantum Mechanics	

Requirements for an Engineering Major, B.S. (88)

MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 281	Differential Equations	3
CH 161	General Chemistry I	3
CS 171	Computer Science I	3
PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
PS 153L	General Physics II Lab	1
or PS 154L	Near Space Research Project	
PS 251W	Modern Physics	4
EN 130	Introduction to Engineering	2
EN 171	Engineering Graphics & CAD	3
EN 211	Statics	3
EN 230	Electric Circuit Analysis	3
EN 230L	Electric Circuit Lab	1
EN 287	Principles of Engineering Design	2
EN 300	Engineering Thermodynamics	3
EN 320	Fluid Mechanics and Heat Transfer	3
EN 321L	Thermal and Fluids Laboratory	1
EN 330	Semiconductor Electronic Devices	3
EN 330L	Electronic Devices Lab	1
EN 335	Signals and Systems	3
EN 351	Dynamics	3
EN 356	Mathematical Methods I	2
EN 358	Mathematical Methods II	2
EN 388	Internship Preparation	1
EN 393	Internship Reflection	1
EN 484	Engineering Design Project I	2
EN 487H	Engineering Design Project II	3
One of the following:		3
EN 173	Introduction to Embedded Systems	
EN 181	Manufacturing Processes	
EN 271	Computational Methods	
One of the following:		3
EN 311	Mechanics of Materials	
CS 373	Digital Logic Design	
One of the following:		3
EN 411	Materials Science and Engineering	
PS 451	Electricity and Magnetism I	
One of the following:		4
PS 353	Advanced Dynamics	
PS 361	Nuclear Physics	
PS 371	Optics	
PS 453	Electricity and Magnetism II	
PS 455	Quantum Mechanics	

Important Notes for the B.S. in Engineering Program

Due to their resource-intensive nature, five courses in the department are restricted to students who have been admitted to the B.S. in Engineering. The restricted enrollment courses are: EN 287, EN 321L, EN 330L, EN 484 and EN 487H.

Standard Admission Process

Students wishing to be admitted to the B.S. in Engineering program will normally apply during their sophomore year. Applicants must have completed the engineering foundation courses:

1. All of the following: PS 151, PS 151L, PS 153, PS 153L (or PS 154L), PS 251W, MA 171, MA 172 and MA 273
2. At least three of the following: EN 130, EN 171, EN 211, CH 161 and CS 171

An application consists of the following:

1. Applicant information form (available online),
2. A one- to two-page essay describing the applicant's reasons for pursuing a major in engineering, and
3. A one- to two-page essay describing the applicant's growth academically and professionally while at Whitworth.

Applications must be submitted via email to the department program assistant by the first Friday in the spring semester. Applicants will be informed whether or not they have been admitted to the B.S. in Engineering program by the second Friday in March.

Applicants denied admission to the B.S. in Engineering may submit an appeal, due two weeks after the end of the spring semester. Students will receive a response to the appeal by the end of June.

Transfer Student Policies

An entering transfer student may apply for admission to the B.S. in Engineering prior to his/her first semester at Whitworth. Transfer applicants must have completed the equivalents of Whitworth's engineering foundation courses (see above). The application has the same format as that for other students with the exception of the second essay. This essay should describe academic and professional growth since the student started taking college-level courses. The application materials must be received no later than four weeks prior to the first class day of the student's first semester at Whitworth. The application will be reviewed within three weeks of being received. Alternatively, transfer students may apply for admission to the program through the standard process in the spring semester.

Because our graduates represent the quality of our program to the outside, it is important that those earning the B.S. in Engineering truly reflect that education. We therefore require transfer students to complete at least 48 credits at Whitworth in order to earn the B.S. in Engineering.

Dual Degree Pre-Engineering Transfer Program

Pre-engineering advisor: Richard Stevens

Whitworth's pre-engineering program is designed to give students the broad foundation of a liberal arts education, as well as technical training to be successful in a variety of engineering disciplines. Arrangements have been made with several top engineering schools to allow pre-engineering students to complete their first two or three years of coursework at Whitworth and the remainder of the five-year program at a partner engineering school. Partnership arrangements exist with Washington University (St. Louis), Washington State University and Columbia University. Students report that the broad knowledge base and the critical-thinking, teamwork and communication skills acquired at Whitworth have enabled them to thrive in both engineering school and the professional environment. Recent graduates are working at successful engineering firms around the country. The following courses are required to qualify for our partner engineering schools, with additional courses available to prepare for specific engineering fields.

Pre-Engineering Recommended Courses (39)

EN 130	Introduction to Engineering	2
PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
PS 153L	General Physics II Lab	1

PS 251W	Modern Physics	4
MA 171	Calculus I	4
MA 172	Calculus II	4
MA 273	Calculus III	4
MA 281	Differential Equations	3
CH 161	General Chemistry I	3
CH 161L	General Chemistry I Lab	1
CS 171	Computer Science I	3
EL 110	Writing & Design	3

Requirements for a Physics Minor (21-24)

PS 151	General Physics I	3
PS 151L	General Physics I Lab	1
PS 153	General Physics II	3
One of the following:		1
PS 153L	General Physics II Lab	
PS 154L	Near Space Research Project	
PS 251W	Modern Physics	4
Three additional courses in physics (with no more than one of these at the 100-level)		9-12
Complete the following courses for Washington state endorsement in physics:		
MA 256	Elementary Probability and Statistics (3)	
MA 273	Calculus III (4)	
EDU 455W	Science in Secondary School (2)	
MA 281	Differential Equations (3)	
EN 121	Epic Fails in Engineering	
All endorsements subject to change; see School of Education for updated requirements.		

Requirements for a Science Endorsement for Majors in Biology, Chemistry or Physics

The science endorsement requires a major in biology, chemistry or physics plus additional courses. For a list of these additional courses, please see the biology or chemistry sections of the catalog.

Interdisciplinary Courses

STEM 126 Seminar for Health Professions **1**

A seminar to introduce students to the pre-health fields. Visiting speakers will represent medical, dental, pharmacy, and veterinary fields. This course will cover the specifics of courses, majors, and other issues related to pre-health fields. Students will also reflect on the importance of the connections between academic disciplines as they consider future vocational options. Recommended for pre-health professional students interested in the fields listed above. This seminar fulfills the SC 126 Shared Curriculum requirement. Spring semester.

STEM 351 Preparatory Seminar: Health Professions **1**

A cross-disciplinary course focusing on synthesis of general biology, general chemistry, general physics, organic chemistry, physiology, NMR and IR spectroscopy. Strategic course for learning to apply introductory science/math knowledge to questions involving higher-order content. Intended for students planning to take the Medical College Admissions Test, Dental Aptitude Test, or veterinary-school entrance exams. Intended primarily for students in their junior or senior year. Students will prepare for health professions both in terms of the entrance exams and by researching each school's focus and prerequisites. Prerequisites: BI 140, BI 143, CH 161, CH 181, CH 271, CH 278, PS 151 & 153 or PS 131 & 133.

EN Courses

EN 121 Epic Fails in Engineering **3**

This course will study notorious engineering failures and the scientific, political, and ethical considerations that are associated with these disasters. Failure will be studied not only for its negative consequences, but also from a redemptive perspective. This class is intended for non-science majors, and a high-school level knowledge of algebra and geometry is expected.

EN 130 Introduction to Engineering **2**

This course introduces students to the way different engineering disciplines contribute to society, so they can begin to understand their career options. The course also describes the degree options available to Whitworth students and their respective requirements. The course includes an engaging design project and orientation to the engineering tool shop. Spring semester. Co-requisite MA-171.

EN 171 Engineering Graphics & CAD **3**

An introduction to modern concepts, standards, and techniques for preparing technical drawings and CAD models that provide effective communication between design engineers, analysts, and fabricators. Engineering graphics techniques including spatial visualization, two- dimensional sketching, multi-view orthographic projection, pictorial drawing, solid modeling, and working drawings will be accomplished using computer aided design software. Fall and spring semesters.

EN 173 Introduction to Embedded Systems **3**

This course provides an introduction to embedded systems, the computers that are inside the devices you use each day and which allow those devices to monitor and react to the outside world. Learn about the hidden workings of the systems designed by engineers to make modern cars and phones smart. Some prior programming experience recommended. January.

EN 181 Manufacturing Processes **3**

A comprehensive introduction to the processes used in the manufacture of plastic and metal products. This course focuses primarily on the practical aspect of manufacturing, such as process steps and machinery. The concepts discussed in class will be augmented with multiple field trips to local manufacturing facilities. Students will gain a beginning experience which informs design and tradeoffs in the choice of material, features, and process selection.

EN 211 Statics **3**

Mathematical review, equilibrium of a particle, free-body diagrams, equilibrium of a rigid body, structural analysis, friction, center of gravity, moments of inertia. Prerequisite: PS 151 and MA 171. Fall semester.

EN 230 Electric Circuit Analysis **3**

Introduction to fundamentals of electric circuit analysis. Techniques include node-voltage, mesh-current, phasor representation, and Laplace transform. Transient and steady-state responses of RLC circuits. Single-phase sinusoidal steady-state and three-phase balanced systems. Introduction to filters and operational amplifiers. Circuit simulation with PSpice. Prerequisite: PS 153. Co-requisite: MA 281. Spring semester.

EN 230L Electric Circuit Lab **1**

Design, assembly, and testing of electrical circuits with a focus on linear analog systems. Introduction to the use of common laboratory electronic equipment. Co-requisite: EN 230. Spring semester.

EN 254H CubeSat Research and Development **1**

A practicum course for students involved in a multi-year effort to design, build, test, launch, and monitor a small satellite.

EN 271 Computational Methods **3**

Introduction to the investigation of physical processes using computers. Survey of various computational techniques to solve equations commonly used in physics and engineering. This is a hands-on course with an emphasis on solving these equations for applications in physics. Prerequisite: MA 273. January, even years.

EN 287 Principles of Engineering Design **2**

Introduction to methodologies, goals and challenges in engineering design. Also covers issues in communication, cost analysis, and ethics in engineering design. Restricted to students who have been admitted to the B.S. in Engineering. Prerequisite: EN 130. Co-requisite: EN 171. Spring Semester, Even Years.

EN 300 Engineering Thermodynamics **3**

This course will cover the interaction of matter and energy, analyze energy transfer, and consider the limitations of thermodynamic systems due to energy and entropy. These considerations will be applied to real-world applications such as engines and heat pumps. Prerequisite: PS 153. Spring semester, even years.

EN 311 Mechanics of Materials **3**

Basic concepts of solid mechanics & mechanical behavior of materials, including stress-strain relationships, stress transformation, beam bending, elasticity, plasticity and fracture. Quantitative analysis of materials-limiting problems in engineering design. Prerequisite: EN 211. Spring semester, odd years.

EN 320 Fluid Mechanics and Heat Transfer **3**

This course presents the fundamentals of both fluid mechanics and heat transfer from an engineering perspective. The fluids portion considers fluid statics, fluids in motion, momentum and energy equations, boundary layers, internal flows (e.g. pipes), and external flow (drag and lift). The heat transfer portion considers steady and transient conduction, internal and external forced convection, natural convection, radiation heat transfer, and heat exchangers. All topics are presented in the context of real world applications to create engineering estimates of performance. Prerequisite: EN 300. Fall semester, even years.

EN 321L Thermal and Fluids Laboratory **1**

Practical experience measuring thermodynamics, fluid mechanics, and heat transfer phenomenon with an emphasis on applications in engineering and making engineering judgments based on data. Restricted to students who have been admitted to the B.S. in Engineering. Co-requisite: EN 320. Fall semester, even years.

EN 330 Semiconductor Electronic Devices **3**

Provides a foundation in the science of semiconductor materials so the student is able to understand the characteristics and behavior of semiconductor electronic devices. Key devices such as diodes, field-effect transistors, and bipolar junction transistors are examined in detail. Prerequisite: PS 251W and EN 230. Spring semester.

EN 330L Electronic Devices Lab **1**

Experimental measurement of properties of semiconductor materials, pn-junction diodes, bipolar junction transistors, and field effect transistors. Also includes an introduction to the application of these devices. Restricted to students who have been admitted to the B.S. in Engineering. Co-requisite: EN 330. Spring semester.

EN 335 Signals and Systems **3**

An introduction to time and frequency domain analysis of continuous-time and discrete-time signals and linear systems. Topics include Fourier series, Fourier transform, fast Fourier transform, Laplace transform, z transform, convolution, sampling, aliasing, communications, modulation, and filters. Prerequisite: EN 230. Fall semester, even years.

EN 351 Dynamics **3**

Fundamental principles and methods of Newtonian mechanics including kinematics and kinetics of motion and the conservation laws of mechanics. Basic particle and rigid-body applications. Also listed as PS 351. Prerequisites: PS 153 and MA 281. Fall semester, odd years.

EN 356 Mathematical Methods I **2**

Survey of various mathematical methods commonly used in physics and engineering. Topics covered will include linear algebra, vector calculus, and complex analysis. The emphasis will be not just on the mathematical theory, but also on the various applications of these methods. Prerequisite: MA 273. Spring semester.

EN 358 Mathematical Methods II **2**

Survey of various mathematical methods commonly used in physics and engineering. Topics covered will include ordinary differential equations, elliptic, parabolic, and hyperbolic partial differential equations, and various analytical and numerical solution techniques for them. The emphasis will be not just on the mathematical theory, but also on the various applications of these methods. Prerequisite: MA 273 and MA 281. Fall semester.

EN 388 Internship Preparation **1**

Students will receive guidance in seeking an internship and will set objectives for that experience. Reading and reflection will deepen students' understanding of the role of work in life and how that is shaped by faith and values. Fall semester.

EN 393 Internship Reflection **1**

Students will assess an internship experience and how it has shaped their thinking about their career. Reading and reflection will further deepen their understanding of the role of work in life and important workplace issues. Fall semester.

EN 411 Materials Science and Engineering **3**

This survey course introduces the atomic nature of materials and how it can be manipulated and intentionally designed. Materials processing is connected with the resulting properties and performance of engineering materials. Prerequisite: PS 251W. Fall semester, odd years.

EN 454H CubeSat Leadership **1**

A practicum course for student leaders involved in a multi-year effort to design, build, test, launch, and monitor a small satellite.

EN 484 Engineering Design Project I **2**

This is the first course in a two-course capstone design sequence. In this sequence students apply engineering procedures and practices to a comprehensive design project. Throughout both courses the students work in teams to create typical industry project documentation such as written reports, CAD models and drawings, engineering performance estimates, schedules and status reports, and oral presentations. Emphasis in the first course is on early project work such as initial planning, alternative solution generation, and initial design models and analyses. Restricted to students who have been admitted to the B.S. in Engineering. Prerequisite: EN 287. Fall semester, Even years.

EN 487H Engineering Design Project II **3**

This is the second course in a two-course capstone design sequence. In this sequence students apply engineering procedures and practices to a comprehensive design project. Throughout both courses the students work in teams to create typical industry project documentation such as written reports, CAD models and drawings, engineering performance estimates, schedules and status reports, and oral presentations. Emphasis in the second course is on project completion. Typical work includes completion of design detailing, performance analyses, prototype construction, verification testing, and final reporting. Restricted to students who have been admitted to the B.S. in Engineering. Prerequisite: EN 484. Spring Semester, Odd Years.

EN 488 Engineering Analysis in Design Practicum **3**

This course reinforces the use of engineering analysis in an open-ended design project. Students will use engineering analysis to estimate the performance of alternative project design concepts. These estimates will be used to compare and down select competing alternatives relative to design target specifications. The chosen design alternative will be fully documented with engineering drawings and appropriate analysis. This work will be summarized in the final engineering reports. The major emphasis in this course will be applying prior coursework to an open-ended design project. All project work will be completed in teams utilizing the design process.

GL Courses

GL 131 Understanding Earth **4**

Structure of the earth and the forces of plate tectonics that build and move continents. Examination of the dynamic interactions between the lithosphere (crust), atmosphere, and hydrosphere. Laboratory included. Also listed as ENS 131.

GL 131L Lab: Understanding Earth **0**

GL 139 Environmental Geology **3**

Interactions of the human species with land, sea and air. Geologic hazards, earth resources, oceanography, meteorology. Also listed as ENS 139.

GL 141 Introduction to Oceanography **3**

This course provides a broad introduction to the oft times mysterious oceanographic realm. Topics include: nature of the seafloor; seabed resources; chemical and physical properties of water; currents, waves and tides; coastlines; primary production and other "life in the water".

GL 149 Science in Hawaii **4**

This science course is taught on the "Big Island" of Hawaii and is designed to provide a basic understanding of foundational earth science topics including: plate tectonics; earthquakes; volcanoes; coastlines; climates; renewable energy; and Earth's place in the Universe.

NS Courses

NS 101 Earth and Sky **3**

A broad study of earth science including geology and astronomy, oceans, the atmosphere and fundamental underlying physical concepts. Includes the nature and the origin of the solar system, the structure of the earth, and how earth processes operate and affect human life; for example: volcanoes, earthquakes, rivers, groundwater, glaciers, ocean processes, atmosphere and weather. For elementary education students. Also listed as ENS 101. Fall and spring semesters.

NS 103 Climate Change: Past, Present & Future **3**

Climate change is a global problem that requires understanding, a sense of concern and then action to be solved. Understanding will be accomplished by learning about mechanisms that have produced changes in global climate over the past millions of years, what is presently occurring and what can be accurately predicted for the future. Through this understanding, students will develop a stronger sense of caring for our planet and, from caring, create openings for action. Climate is energized by ocean temperatures. Ocean currents, both surface and flowing deeply undersea, bring this stored energy to interact with the atmosphere throughout the globe. This energy produces air temperature, rainfall and wind patterns. Radical climate changes have occurred throughout geological history. We will study why these changes have occurred and learn that they have taken place over thousands of years, allowing life to adapt. We are presently experiencing similar changes that are occurring over decades; and they are projected to accelerate over the foreseeable future. We will explore the agents of these changes, what can be done to reduce the impact as well as what we must do to adapt.

PS Courses

PS 101 Physics of Weapons **3**

A science course specifically designed for non-majors, this course will examine the ties between science and the technology of weapons. Societal impacts of these weapons and Christian responses will be examined. The primary focus of the course will be on physics, and knowledge of high-school algebra and geometry is expected.

PS 121 Concepts of Physics **3**

A study of fundamental unifying ideas of physics and of how scientists learn about the physical world. Emphasis on the comprehension of concepts. For non-science majors. Periodic offering.

PS 123 Origins 3

Examination of the human quest to understand the origins of the Universe. Emphasis given to the historical development of scientific theories and the spectrum of Christian perspectives on origins. For non-science majors; algebra and geometry will be used. Periodic offering.

PS 125 Introduction to the Cosmos 3

This course provides a broad introduction to the science of astronomy. The initial emphasis consists of a brief overview of the universe and of scientific inquiry, as well as historical astronomy. Subsequent studies take an inside-out approach beginning with residents of the solar system and then progressing to stars, pulsars, black holes, and galaxies. The course also examines the factors that contribute to Earth's ability to sustain life. The last topic to be considered is cosmology, the science of the origin and development of the universe. Throughout the course we will contemplate the tensions that arise when viewing our universe through the lenses of divine action and natural forces.

PS 127 Introduction to Space Flight 3

A study of the scientific concepts behind the development and practice of space flight. Other topics include the history of space flight, military applications, socio-political implications, crew training, commercial spinoffs of space exploration and the outlook for the future. For non-science majors. Prerequisite: MA 107 or MA 108. Periodic Jan Term offering.

PS 131 College Physics for Life Sciences 3

The first in a two-semester sequence of basic physics designed to present concepts and applications of the following: kinematics, dynamics, gravitation, energy, momentum and heat. High school-level algebra and trigonometry will be used. There are three hours of lecture a week, and an associated laboratory PS 131L.

PS 131L College Physics for Life Sciences Labora tory I 1

Laboratory accompanying PS 131

PS 133 College Physics for Life Sciences II 3

The second in a two-semester sequence of basic physics designed to present concepts and applications of the following: Electricity and Magnetism, Optics,Sound and Waves, Quantum and Nuclear physics.

PS 133L College Physics for Life Sciences Lab II 1

Laboratory associated with PS 133

PS 141 Introduction to Astronomy 4

Nature and origin of the solar system, starlight and star life, components and structure of a galaxy, the expanding universe and cosmology. Astronomical instruments are also discussed. Includes laboratory. Spring semester.

PS 146 Physics in Current Events 3

Using current events as a starting point, we will discuss the physics behind these events and explore where it leads. Topics may include forces, energy, waves, sound, electricity and magnetism, heat, fluids, relativity, nuclear and particle physics, astronomy, and astrophysics. The selection will be based largely on current events in news media, such as newspapers, TV, radio, and the Internet. Students are encouraged to suggest topics of interest to them. Course includes a lab component. Fulfills the natural science requirement. Also listed as ENS 146.

PS 151 General Physics I 3

Basic principles of mechanics. Corequisite: PS 151L & MA 171. Fall semester.

PS 151L General Physics I Lab 1

Laboratory experiments in mechanics. Includes an introduction to the propagation of uncertainty. Prerequisite: PS 151 or concurrent enrollment. Fall semester.

PS 153 General Physics II 3

Basic principles of thermodynamics, electricity and magnetism. Prerequisites: PS 151, also MA 172 or concurrent enrollment. Spring semester.

PS 153L General Physics II Lab **1**

Laboratory experiments in thermodynamics, electricity and magnetism. Prerequisites: PS 151L, also PS 153 or concurrent enrollment. Spring semester.

PS 154L Near Space Research Project **1**

Laboratory course involving the design, implementation, testing, and analysis of an experiment in near space. Provides project-based learning in thermodynamics, electromagnetism, and electronics.

PS 200 Physics Outreach **1**

Promotion of physics and engineering education through service-learning in the community. An example of this outreach is working with local middle school students to help design and construct experiments to be flown to the upper atmosphere with a high-altitude balloon.

PS 251W Modern Physics **4**

Continuation of PS 153. Basic principles of optics special relativity, and modern physics. Includes laboratory. Prerequisite: PS 153. Completion of this three-semester sequence is the normal pattern for entry into all upper-level physics courses. Fall semester.

PS 251L Lab: Modern Physics **0**

PS 351 Dynamics **3**

Fundamental principles and methods of Newtonian mechanics including kinematics and kinetics of motion and the conservation laws of mechanics. Basic particle and rigid-body applications. Also listed with EN 351. Prerequisites: PS 153 and MA 281. Fall semester, odd years.

PS 353 Advanced Dynamics **4**

Continuation of PS 351. Numerical techniques in dynamics, velocity-dependent forces, oscillations (linear, nonlinear, and coupled), motion in a noninertial reference frame, and alternative formulations of mechanics (Lagrangian and Hamiltonian). Requires concurrent registration in laboratory (PS 353L). Prerequisite: PS 351. Spring semester, even years.

PS 353L Advanced Dynamics Lab **0**

PS 361 Nuclear Physics **4**

Nuclear structure, radioactivity, nuclear reaction interactions of nuclear radiations with matter. Includes Lab. Prerequisites: PS 251W. Fall semester, even years.

PS 361L Lab: Nuclear Physics **0**

PS 363 Thermal Physics **4**

Statistical mechanics, kinetic theory, laws of thermodynamics and states of matter. Implications for engines and other applications in many areas of science. Includes laboratory. Prerequisites: PS 251W and MA 281. Spring semester, odd years.

PS 363L Lab: Thermal Physics **0**

PS 371 Optics **4**

Nature of light, geometrical and physical optics, interference, quantum optics, optical instruments. Includes laboratory. Prerequisites: PS 251W and MA 281. Spring semester, even years.

PS 371L Optics Lab **0**

PS 388 Internship Preparation **1**

Students will receive guidance in seeking an internship and will set objectives for that experience. Reading and reflection will deepen students' understanding of the role of work in life and how that is shaped by faith and values. Fall semester.

PS 393 Internship Reflection **1**

Students will assess an internship experience and how it has shaped their thinking about their career. Reading and reflection will further deepen their understanding of the role of work in life and important workplace issues. Fall semester.

PS 451 Electricity and Magnetism I **3**

Electric and magnetic fields, boundary value problems, steady and alternating currents, electrical instruments, and measurement techniques. Prerequisites: PS 153, MA 273, and MA 281. Fall semester, even years.

PS 453 Electricity and Magnetism II **4**

Continuation of PS 451. Maxwell's equations, electromagnetic waves, advanced topics in electrical and magnetic phenomena. Requires concurrent registration in laboratory (PS 453L). Prerequisite: PS 451. Spring semester, odd years.

PS 453L Lab: Electricity and Magnetism II **0**

PS 455 Quantum Mechanics **4**

Principles of quantum mechanics, including Schroedinger's equation applied to the rigid rotor, the hydrogen atom and the harmonic oscillator. Includes laboratory. Prerequisites: PS 251W and MA 281. Fall semester, odd years.

PS 455L Lab: Quantum Mechanics **0**

PS 471 Research in Physics **1-4**

Supervised research projects in areas such as electronics, optics, nuclear physics, computer applications, atmospheric physics. Prerequisite: permission of professor. Jan Term.

PS 473 Experimental Physics **1-4**

Supervised research projects in areas such as electronics, optics, nuclear physics, computer applications, atmospheric physics. Prerequisite: permission of professor.