PHYSICS AND ENGINEERING

Our department serves physics and engineering majors and the general Wheaton student population by providing robust student-centered learning experiences that draw on the unique ways of knowing common to our discipline from a genuinely Christian liberal arts perspective. The study of matter, energy, and their interactions provides fertile ground for enhanced worship of the Creator and for collaborative theoretical, experimental, and computational learning and research among faculty and students in a strong and supportive community. Students grow in their love and worship of God by engaging with His good creation and preparing for lives of service to the church and society.

The engineering program at Wheaton is designed to apply mathematical and scientific knowledge for the benefit of society worldwide within the context of an excellent Christian liberal arts education. Wheaton integrates project-based teaching into the engineering curriculum, emphasizes design, and utilizes modern tools and methodologies.

The department offers several different physics majors leading to a Bachelor of Science or Bachelor of Arts degree. A 4-year Engineering program allows students to complete an Engineering B.S. at Wheaton in four years. A 3-2 dual degree Liberal Arts Engineering program is also available leading to two degrees: a Bachelor of Arts or Science in Liberal Arts Engineering from Wheaton combined with a full Bachelor of Science degree from any other school that offers a fully ABET accredited program in the engineering discipline of interest. Detailed requirements and course offerings for all physics and engineering majors are summarized below.

Physics

The physics curriculum is organized to prepare a student for graduate work in physics or a related discipline as well as a range of other vocations that make use of the analytical and problem solving skills of a physicist.

- The Bachelor of Science with a major in Physics incorporates all of the necessary coursework to prepare a student for graduate work in physics.
- The Bachelor of Arts with a major in Physics overlaps nearly completely with the Bachelor of Science track but allows the student more freedom to select from a set of upper level core courses. The BA degree is not appropriate for those going on to graduate work in physics but provides more flexibility for those who want to double major or study abroad and who plan to go on to professional schools such as law or medicine or go straight into the workplace after graduation.
- The Bachelor of Science with a major in Physics with Teaching prepares students for high school physics teaching.
- The Bachelor of Science with a major in Applied Physics replaces some of the upper division physics requirements with required engineering coursework and is a good choice for those who plan to pursue engineering or a related field after graduation.

All physics majors are strongly encouraged to complete the PHYS 294 requirement in their first year.

The **Departmental Honors Program** is available to all physics majors who maintain a 3.70 GPA in the major, and an overall GPA of 3.50. Eight credit hours of designated honors coursework are required, four of which may consist of a modified major course, and four of which must be PHYS 499, resulting in the completion of a research thesis. Successful completion of the program will result in a Departmental Honors designation on the student's transcript. Students must submit an application to the department at least one year prior to graduation to participate in the honors program. See the department for details.

Engineering Program (4-year)

The 4-year Engineering Program results in a Bachelor of Science degree with a major in Engineering. In the first two years of the program, students will study a common engineering core curriculum and in the second two years they will add a concentration area of study. Students are required to complete a full year culminating design sequence during their senior year in addition to the Christ at the Core Capstone Course.

The 4-year Engineering Program is not yet accredited by ABET but accreditation will be sought following the graduation of the first class in May 2026. If successful, the accreditation will then apply to that first class and all subsequent classes.

Engineering Program (3-2 Dual Degree)

A five-year program is offered leading to two degrees, a Bachelor of Arts or Bachelor of Science degree with a major in Liberal Arts Engineering from Wheaton and a Bachelor of Science degree with a major in a specific engineering field from an ABET accredited engineering program at another institution. This arrangement allows students to complete degrees in a wide array of specific engineering disciplines. The student must meet the requirements of the school to which admission is sought. Special joint programs are in place with Illinois Tech and Northern Illinois University (NIU) but students may transfer to any ABET accredited engineering program at other institutions as well.

Several commonly required lower division engineering courses are offered by engineering faculty at Wheaton to prepare students for successful completion of engineering requirements at the engineering school in the final two years of the dual degree program. (See course information below). Transfer of the Wheaton College engineering courses to meet requirements at engineering schools is likely but not guaranteed. Each student should verify that any courses taken at Wheaton will transfer successfully for the specific program and institution of interest.

The joint program arrangement with Illinois Tech allows students to take other engineering courses not offered at Wheaton during the first three years of the five year program. An agreement with the nearby College of DuPage (COD) also allows students to take selected engineering coursework there during the first 3 years. Students must complete appropriate paperwork and register at both Wheaton College and either Illinois Tech or COD for the courses taught at these institutions. Illinois Tech courses will usually be taken at the Illinois Tech main campus in Chicago but some courses may be made available on internet upon request.

Approved course tracks for the full five years with Illinois Tech and NIU, as the partner schools, are available from the Department. Illinois Tech programs are available in aerospace, architectural, biomedical, chemical, civil, computer, electrical, and mechanical engineering. NIU programs are available in electrical, industrial and systems, and mechanical engineering.

Students completing their engineering coursework at a school in the vicinity of Wheaton College (e.g. Illinois Tech, Northern Illinois University, or University of Illinois - Chicago) during the last two years of the five year

program, by virtue of their continuing in the Wheaton College dual degree program, may remain in Wheaton College housing and may continue to participate fully in extra-curricular activities at the College, including athletics.

See department for course plans, including additional ENGR and other courses that will satisfy requirements at the engineering school of choice. Students in the 3-2 Dual Degree Engineering Program have modified Christ at the Core general education requirements. (Students in the 4-year Engineering Program do not have these modifications). Students are only required to take one 4 hour Foreign Language course, they are not required to complete the Scientific Issues and Perspectives (SIP) theme, and they should choose 4 of the following 5 themes:

- Diversity in the United States (DUS),
- Global Perspectives (GP),
- Historical Perspectives (HP),
- Literary Explorations (LE),
- Philosophical Investigations (PI).

The remaining Christ at the Core requirements are the same as for all other majors. Some engineering schools will require additional coursework beyond the Wheaton requirements prior to transfer. Some schools may also require Christ at the Core Thematic courses to be taken from specific departments. Students should consult with their advisor and the engineering school of interest to ensure courses taken at Wheaton will meet requirements at the engineering school. Up to eight hours of non-major courses at the engineering school may be transferred back to Wheaton to meet Wheaton requirements.

In all cases, the Wheaton Registrar must receive a final transcript from the engineering school indicating that all their engineering requirements have been met. This is normally indicated by the engineering school awarding the undergraduate engineering degree. This final transcript must be received by the Wheaton Registrar before the Wheaton degree in Liberal Arts Engineering will be conferred. Students who complete all Wheaton College course requirements by the end of their fourth year may participate in the commencement ceremonies of that year.

Faculty

Chair, Professor, Darren Craig
Engineering Program Director, Jeff Yoder
Professor, Robert Bishop
Assistant Professors, James Schroeder, Kevin Valson Jacob, Kelly Vazquez

Programs

- Engineering Major, Bachelor of Science (4-year Program) (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/engineering-major-bs/)
- Liberal Arts Engineering, Bachelor of Arts/Bachelor of Science (3-2, Dual Degree Program) (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/liberal-arts-engineering-ba-bs/)
- Physics: Applied Physics, Bachelor of Science (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/physics-applied-physics-bs/)
- Physics, Bachelor of Arts (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/physics-ba/)
- Physics, Bachelor of Science (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/physics-bs/)
- Physics Major with Teaching, Bachelor of Science (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/physics-major-with-teaching-bs/)
- Philosophy Major Integrated with Physics (https://catalog.wheaton.edu/undergraduate/arts-sciences/philosophy/integrated-philosophy-major-physics/)
- Physics Minor (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/physics-minor/)
- Departmental Honors Endorsement: Physics and Engineering (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/departmental-honors-endorsement-physics-and-engineering/)
- Extended Studies in Major Endorsement: Physics and Engineering (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/extended-studies-in-major-endorsement-physics-and-engineering/)
- General Studies Endorsement for Fourth-Year Majors in Physics and Engineering (https://catalog.wheaton.edu/undergraduate/arts-sciences/physics-engineering/general-studies-endorsement-for-fourth-year-majors-in-physics-and-engineering/)

Courses

See the Financial Information (https://catalog.wheaton.edu/financial-information/) section of this catalog for course fees.

Astronomy Courses

ASTR 304. Global History of Cosmology. (4 Credits)
Study of the historical development of cosmology in ancient Egypt, Mesopotamia, India, Greece, Asia, and the Americas through contemporary developments. Cultural and religious interactions with developments in cosmology are emphasized.
Tags: GP, SIP

ASTR 305. Astronomy. (4 Credits)
An introduction to the study of the universe. Topics include the solar system, the formation and evolution of stars and the structure, evolution and origin of the universe. Special attention will be given to the social, historical, philosophical and theological context of astronomical discoveries and controversies.
Tags: SIP

Engineering Courses

ENGR 101. Introduction to the Engineering Profession. (1 Credit)
Introduces students to the engineering profession. The engineering disciplines, problem solving approaches, design processes, professional practices, licensure, engineering ethics, and teamwork will be explored through discussion, reading, research, and guest visits by practicing engineers. The importance of the liberal arts and the impact of faith on the practice of engineering will be explored. Freshmen and sophomores only.

ENGR 105. Fundamentals of Engineering Graphics. (2 Credits)
Introduces students to engineering graphics, the means by which engineers communicate design and fabrication information. Topics cover: utilization of engineering graphics; information on graphics; use of the basic graphic tools; orthographic views in both third and first angle projections; auxiliary, section, isometric, and perspective views. This course acquaints students with the processes that are automated within Computer Aided Drafting and Design (CADD) software and expectations for CADD work product. Lab fee. (lin)

ENGR 125. Introduction to AutoCAD. (2 Credits)
Intro to AutoCAD with emphasis on the fundamentals of Computer-Aided Drafting and Design (CADD). Introduces concepts, techniques and procedures necessary to facilitate a basic functional understanding of AutoCAD and the process of using AutoCAD tools to create, dimension, and annotate basic engineering drawings. Lab fee. (lin)

ENGR 131. Engineering Graphics and Computer Aided Design. (4 Credits)
Introduces students to the usage of engineering graphic design tools to communicate design intent and fabrication plans to manufacturers, contractors, suppliers, and customers. Students sketch, dimension, and annotate engineering models, assemblies, and drawings in 2D and 3D for architectural, structural, and mechanical projects. Topics cover: theory and utilization of engineering graphics; hand sketching and drafting; engineering drawing techniques, angle projection and perspective views; process of using Computer-Aided Design (CAD), including AutoCAD, SOLIDWORKS, and Revit software tools. Engineering design topics and basic shop fabrication processes are introduced. Additional course fee required: $65.

ENGR 132. Engineering Graphics and Computer Aided Design. (3 Credits)
Introduces students to engineering graphics, the means by which engineers communicate design and fabrication information. Topics include: utilization of engineering graphics; information on graphics; use of the basic graphic tools; orthographic views in both third and first angle projections; and auxiliary, section, isometric, and perspective views. This course acquaints students with automated processes in Computer Aided Drafting and Design (CADD) software and expectations for CADD outputs. Additional course fee required: $65.

ENGR 201. Engineering Mechanics 1 - Statics. (4 Credits)
Systems of units; gravitation; Newton's laws of motion; equilibrium and free-body diagrams; particles, forces and moments; structures in equilibrium; centroids and center of mass; moments of inertia; friction; beam loadings; cables; fluids; virtual work and potential energy. Prerequisite: PHYS 231. Pre or Corequisite: PHYS 334.

ENGR 202. Engineering Mechanics II - Dynamics. (4 Credits)
Topics include: kinematics and kinetics of particles; Newton's laws of motion; energy, momentum, systems of particles; rigid bodies; free-body diagrams; mass, acceleration, and force; plane motion of rigid bodies; and, conservation of energy and momentum. Prerequisite: ENGR 201. Pre or Corequisite: MATH 333.

ENGR 204. Innovative Design in Engineering. (4 Credits)
Provides the student engineer with firsthand experience in moving from a stated need to a developed and proof-tested product. Topics include project logbooks and plans, evaluating concepts and selecting a design, preparing design documents, fabrication, development and testing of prototypes, stewardship of the environment, preparation of engineering reports, and principles of contract, engineering, and patent law. Prerequisites: ENGR 201.

ENGR 211. Engineering Mechanics I - Statics. (3 Credits)
Systems of units; gravitation; Newton's laws of motion; equilibrium and free-body diagrams; particles, forces and moments; structures in equilibrium; centroids and center of mass; moments of inertia; friction; beam loadings; cables; fluids; virtual work and potential energy. Lecture and Laboratory. Prerequisite: PHYS 231. Pre or Corequisite: ENGR 334.

ENGR 212. Engineering Mechanics II - Dynamics. (3 Credits)
Topics include: kinematics and kinetics of particles; Newton's laws of motion; energy, momentum, systems of particles; rigid bodies; free-body diagrams; mass, acceleration, and force; plane motion of rigid bodies; and, conservation of energy and momentum. Lecture and Laboratory. Prerequisite: ENGR 211. Pre or Corequisite: MATH 333.

ENGR 214. Innovative Design in Engineering. (3 Credits)
Provides the student engineer with firsthand experience in moving from a stated need to a developed and proof-tested product. Topics include project logbooks and plans, evaluating concepts and selecting a design, preparing design documents, fabrication, development and testing of prototypes, stewardship of the environment, preparation of engineering reports, and principles of contract, engineering, and patent law. Prerequisite: Sophomore standing.

ENGR 223. Strength of Materials. (4 Credits)
Provides a broad range of knowledge of the behavior of materials under load. Topics include: mechanical properties; plane stress and strain; stress and strain relations; axially loaded members; Mohr's circle; stress transformation; torsion of shafts; bending and normal and shear stresses in beams; beam deflection; and combined loading. Prerequisite: ENGR 201.

ENGR 225. Materials Science. (4 Credits)
Presents the scientific principles underlying the structural analysis of ceramic, composite, metallic (including semiconductors), and polymeric materials. Topics include atomic bonding and structure, electronic structure, micro- and macrostructure. Principles of structural effects on the chemical, mechanical, and physical properties of material are also addressed. Prerequisites: ENGR 201 and CHEM 231.

ENGR 235. Materials Science for Engineering. (3 Credits)
Presents the scientific principles underlying the structural analysis of ceramic, composite, metallic (including semiconductors), and polymeric materials. Topics include atomic bonding and structure, electronic structure, micro- and macrostructure. Principles of structural effects on the chemical, mechanical, and physical properties of material are also addressed. Lecture and Laboratory. Prerequisite: ENGR 211. Pre or Corequisite: CHEM 231.

ENGR 271. Biology for Engineers. (2 Credits)
This course addresses fundamental concepts and language of biology from an engineering perspective. This course investigates the dynamic and complex systems of biology and integrates this with human design. A list of topics that will be chosen from includes: cell biology; genetics; the functions of living systems and constraints on life's boundaries; the integration of cells into tissues; organ systems; the movement of molecules, cells, and tissues; structure and function of biological tissues; engineering applications in biology, such as the design of replacement tissues and materials. Prerequisite: ENGR 101.

ENGR 302. Engineering Systems Analysis. (2 Credits)
Introduction to engineering systems analysis. This course focuses on modeling engineered system response to a set of design parameters. Application to broad disciplines including mechanical, electrical, chemical, and aerospace. Prerequisite: MATH 333.

ENGR 313. Mechanics of Materials. (3 Credits)
Provides a broad range of knowledge of the behavior of materials under load. Topics include: mechanical properties; plane stress and strain; stress and strain relations; axially loaded members; Mohr's circle; stress transformation; torsion of shafts; bending and normal and shear stresses in beams; beam deflection; and combined loading. Lecture and Laboratory. Prerequisite: ENGR 211. Pre or Corequisite: MATH 333.

ENGR 323. Design of Machine Elements. (2 Credits)
Design of machine elements based on analysis of stress, deformation and failure. Introduction to finite element method in failure analysis and design. Prerequisite: ENGR 223.

ENGR 325. Solid Mechanics. (2 Credits)
Advanced solid mechanics. Topics include elasticity, plasticity, stress distribution, energy methods, creep, fatigue, fracture mechanics. Prerequisite: ENGR 313.

ENGR 333. Mechatronics. (4 Credits)
This course covers mechatronic design including circuits, sensors, actuators, analog and digital electronics, and microcontrollers. Students integrate electronics with real-time programming. Prerequisite: PHYS 351.

ENGR 334. Computer Modeling of Physical Systems. (2 Credits)
An introduction to computer methods for the analysis, modeling and simulation of physical systems and analysis of experimental data. Applications taken from mechanics, fluids, electricity and magnetism. Cross-listed with PHYS 334. Prerequisite: PHYS 231. Pre or Corequisite: MATH 236.

ENGR 336. Fluid Mechanics. (3 Credits)
The study of fluid mechanics is essential in analyzing any physical system involving liquids and gases. The properties of a fluid and the concepts of fluid statics, the integral and differential analyses of fluid motion, and incompressible flow are presented. Applications of these concepts to various engineering situations, such as propulsion systems, aerodynamics, and piping systems, are examined. Pre or Corequisite: ENGR 313 and MATH 237.

ENGR 338. Thermodynamics and Heat Transfer. (3 Credits)
This course introduces the fundamental concepts of thermodynamics and heat transfer. Thermodynamics is the study of energy and its conversion among various forms, particularly heat and work. Laws of thermodynamics are presented in the context of mass and energy conservation using properties such as internal energy, enthalpy, and entropy. Study of the different modes of heat transfer through the development and application of rate equations for quantifying conduction, convection, and thermal radiation heat transfer. Prerequisite: MATH 237 and MATH 333.

ENGR 346. Fluid Mechanics. (4 Credits)
The study of fluid mechanics is essential in analyzing any physical system involving liquids and gases. The properties of a fluid and the concepts of fluid statics, the integral and differential analyses of fluid motion, and incompressible flow are presented. Applications of these concepts to various engineering situations, such as propulsion systems, aerodynamics, and piping systems, are examined. Pre or Corequisite: MATH 237.

ENGR 348. Thermodynamics & Heat Transfer. (4 Credits)
This course introduces the fundamental concepts of thermodynamics and heat transfer. Thermodynamics is the study of energy and its conversion among various forms, particularly heat and work. Laws of thermodynamics are presented in the context of mass and energy conservation using properties such as internal energy, enthalpy, and entropy. Study of the different modes of heat transfer through the development and application of rate equations for quantifying conduction, convection, and thermal radiation heat transfer. Theory and applications are reinforced and complemented by a laboratory component of the course. Prerequisite: MATH 237, MATH 333.

ENGR 351. Analog Electronics. (2 Credits)
Basic principles of electronic circuits and devices. AC and DC circuit fundamentals, filters, diodes, transistors, amplifiers, and operational amplifiers. Four hours lecture, three hours laboratory. Cross-listed with PHYS 351. Prerequisite: PHYS 232. Pre or Corequisite: ENGR 334.

ENGR 352. Fundamentals of Environmental Engineering. (3 Credits)
This course introduces fundamental concepts, practices, and designs of environmental engineering relevant to water and wastewater, air pollution, solid waste management, and other environmental hazards. A focus on sustainability will run throughout the course. Pre or Corequisite: Math 333 and CHEM 231.

ENGR 354. Water Resources Engineering. (3 Credits)
Introduces the fundamental concepts of hydrology and the application of hydraulics in the natural and built environment. Topics include the hydrologic cycle, infiltration and runoff, surface water and groundwater flow, pipe networks and water distribution systems, open channel flow and design, and drainage and stormwater infrastructure. Prerequisite: ENGR 336.

ENGR 356. Structural Analysis and Design. (3 Credits)
This course introduces the basic tools of structural analysis and design for buildings, bridges, and other structures. Topics include: design loads; equilibrium of external and internal forces; shear and moment diagrams in beams and frames; truss analysis; influence line diagrams; the slope-deflection method; the consistent deformation method; and matrix stiffness methods for beams, frames, and trusses. Prerequisite: ENGR 313.

ENGR 358. Groundwater Hydrology and Well Hydraulics. (2 Credits)
In this course students will study the movement and properties of groundwater and its environs, focusing on quantitative analysis, modeling, and design. The course will pay particular attention to macro and micro-level sustainable extraction and development of groundwater resources through appropriate well and pump design and operation. Prerequisite: ENGR 354.

ENGR 359. Geotechnical Engineering. (2 Credits)
With a focus on how soil and rock support and affect structures built on or below the surface of the earth, this course introduces students to principles that govern the behavior of soils, foundations, and other geotechnical engineering works. Prerequisite: ENGR 313.

ENGR 371. Biomaterials. (3 Credits)
This course introduces the field of biomaterials used in the design of medical devices and replacement of soft and hard tissues. The interactions between cells and the surfaces of biomaterials will be presented. In-depth coverage will be focused on basic material sciences, bulk properties, characterization techniques, applications, and in vivo behavior of different classes of natural and synthetic biomaterials. Course topics will be selected from the following list: surface chemistry of selected metals, polymers, and ceramics; surface characterization methodology; modification of biomaterials surfaces; quantitative assays of cell culture; biosensors and microarrays; bulk properties of implants; and immune response to implanted biomaterials. Prerequisite: ENGR 211.

ENGR 372. Cell and Tissue Engineering. (3 Credits)
This course is designed to familiarize current and future researchers with tissue engineering concepts and current practice. A selected list of topics will be chosen from: tissue morphogenesis and homeostasis, stem cells, cell signaling, cell nutrition, cryopreservation, biomaterials, tissue engineering scaffolds, biocompatibility, and ethics. Prerequisite: ENGR 211 and ENGR 271.

ENGR 373. Biomechanics. (3 Credits)
This semester-long course is the introduction to biomechanics concepts. Concepts will project the current mechanics knowledge (drawing from statics, dynamics, solid mechanics) to navigate applying deformations in biomaterials. This course will focus on the theory behind engineering design, predicting failure, and professional practice while providing students with a brief overview of how biomedical engineers apply mechanics in the real world. Course topics will be chosen from the following: stress and strain relations; constitutive equations; stress transformation; bending and normal and shear stresses in biological materials; fatigue failure; and viscoelasticity. Prerequisite: ENGR 313.

ENGR 374. Biomedical Device Design. (3 Credits)
This course gives exposure to the entire biomedical design process from problem definition to prototype validation. The course is organized like a biomedical engineering company, with projects sponsored by real clients from research labs and local industry partners. This semester comprises the following biomedical design components: Problem Definition, Concept Generation and Evaluation, Detailed Design, FDA Approval and Clinical Trials, Validation, Project Management, and Technical Communication. Prerequisite: ENGR 271 and ENGR 313.

ENGR 375. Biomedical Imaging. (3 Credits)
This course introduces fundamentals of the state-of-the-art clinical medical imaging modalities: X-ray, Ultrasound, Radionuclide, Optical Microscopy Techniques, and MRI. The primary focus is on the physical principles, instrumentation methods, and imaging algorithms. Additionally, the medical interpretation of images, with clinical, research and ethical issues in medical imaging are also included where possible to give students a deeper understanding of the development and applications of medical imaging. Topics will be chosen from: Basic concepts of medical imaging; Generation and detection of x-rays, x-ray methods; Computed Tomography; Ultrasound: Acoustic fundamentals, generation and detection, diagnostic methods, biological effects; Radionuclide methods, Nuclear Magnetic Resonance (NMR/MRI), MRI methods; Biological effects of EM fields; Emerging areas in medical imaging. Prerequisite: ENGR 211 and ENGR 271.

ENGR 394. Engineering Ethics Capstone. (2 Credits)
Engineering ethics and vocation; connections between the liberal arts educational experience and the practice of engineering. Prerequisite: Junior standing in the major. Seminar format meeting once per week for the full semester. (lin)
General Education: SHAR

ENGR 396. Internship. (1 to 4 Credits)
Supervised off-campus experience with departmental approval. Graded pass/fail. Prerequisite: junior or senior standing with Liberal Arts Engineering major.

ENGR 451. Senior Design I. (4 Credits)
Engineers create products, systems, and processes to solve problems and meet societal needs. Students work in collaborative teams to solve a real-world problem for a client. Students learn how to utilize the engineering design process to understand and define user needs, develop prototypes, generate drawings, and carry out experimental tests. They learn oral and written communication skills needed in engineering design and build creativity, independent thinking, and the ability to overcome unexpected problems. Prerequisite: ENGR 214.

ENGR 452. Senior Design II. (2 Credits)
Engineering students build upon the design experiences of ENGR 451 to deliver a product, system, or process to market. Students are introduced to advanced design processes including design for reliability, design for manufacturing, design for the environment, industrial design, and human factors. Students learn the basics of patent law and conducting prior art searches. They consider ethical and justice issues in engineering outputs as well as potential policy and societal interactions. Students develop a well-defined business plan. Focus is given to collaboration, project management, working with customers, and refining written and oral communication skills. Prerequisite: ENGR 451.

ENGR 494. Engineering Ethics Capstone. (2 Credits)
Engineering ethics and vocation; connections between the liberal arts educational experience and the practice of engineering. Seminar format meeting once per week for the full semester. Prerequisite: Junior or senior standing in the major.
General Education: SHAR

ENGR 495. Independent Study. (1 to 4 Credits)
Independent research.

ENGR 496. Internship. (0 to 4 Credits)
Supervised off-campus experience with departmental approval. Graded pass/fail.

ENGR 499. Honors Thesis. (2 to 4 Credits)
An independent project providing original engineering research developed in a scholarly paper and culminating in an oral examination.

Physics Courses

PHYS 221. General Physics I. (4 Credits)
Newtonian mechanics, energy, waves, and heat. Non-calculus based. Four hours lecture, three hours laboratory. Prerequisite: Pre-calculus (algebra and trigonometry) competence. Not open to students with prior credit for PHYS 231 or 233.
Tags: SP

PHYS 222. General Physics II. (4 Credits)
Electromagnetism, optics, and modern physics. Non-calculus based. Four hours lecture, three hours laboratory. Prerequisite: PHYS 221. Not open to students with prior credit for PHYS 232 or 234.

PHYS 231. Introductory Physics I. (4 Credits)
Kinematics, Newtonian dynamics, conservation laws, and selected topics from oscillations, waves, fluids, and thermodynamics. Four hours lecture, three hours laboratory. Corequisite or Prerequisite: MATH 235.
Tags: SP

PHYS 232. Introductory Physics II. (4 Credits)
Electricity and magnetism, optics, and selected topics from modern physics, waves, and thermodynamics. Four hours lecture, three hours laboratory. Prerequisite: PHYS 231. Pre or Corequisite: MATH 236.

PHYS 294. Physics for the Future. (2 Credits)
The beginning of an exciting journey into the intricacies of our created world. Includes discussion of recent physics breakthroughs, exposure to research at Wheaton and at nearby national laboratories, discussion of vocational pathways, and thoughts on the relationship of physics to the liberal arts and the Christian faith. (lin)

PHYS 305. Dakota Skies: Astronomy and Atmospheric Science in the Black Hills. (4 Credits)
An introduction to the study of the weather and the universe. Topics include physical foundations for astronomy and atmospheric science, the evolution of stars, the structure and origin of the universe, the structure of the earth's atmosphere, weather systems, weather analysis and forecasting. Special attention will be given to sound scientific practices, including systematic scientific investigations, critical evaluation of scientific claims and the ability to develop a sound scientific argument.

PHYS 331. Spacetime and Quanta. (4 Credits)
Special Relativity, Quantum Mechanics, and selected topics from Atomic Physics, Statistical Physics, Nuclear Physics, Particle Physics, Solid State Physics, and Cosmology. Four hours lecture. Prerequisites: PHYS 232 and PHYS 334. Co or Prerequisite:MATH 333.

PHYS 334. Computer Modeling of Physical Systems. (2 Credits)
An introduction to computer methods for the analysis, modeling and simulation of physical systems and analysis of experimental data. Applications taken from mechanics, fluids, electricity and magnetism. Cross-listed with ENGR 334. Prerequisite: PHYS 231 and MATH 235. Pre or Corequisite: MATH 236.

PHYS 341. Analytical Mechanics. (4 Credits)
Particle and rigid body dynamics, central forces and gravitation, rotating systems and bodies, Lagrange and Hamilton formulations, generalized coordinates, and normal modes. Prerequisite: PHYS 334 and MATH 333. Pre or Corequisite: MATH 237.

PHYS 342. Electromagnetic Theory. (4 Credits)
Electrostatics, steady currents, linear materials, electromagnetic induction, Maxwell's equations, and electromagnetic waves. Alternate years. Prerequisite: PHYS 334 and MATH 237. Pre or Corequisite: MATH 333.

PHYS 343. Methods of Experimental Physics. (2 Credits)
Design of scientific investigations; experimental methods and instrumentation; construction of scientific arguments from data. Six hours laboratory. Prerequisites: PHYS 334 and Junior or higher standing. (lin)

PHYS 344. Quantum Mechanics. (4 Credits)
Elements of quantum physics, solutions of Schrödinger's equation applied to atomic and molecular structure, applications, interpretations. Alternate years. Prerequisite: PHYS 331 and 334; and MATH 237, 245, and 333.

PHYS 345. Methods of Data Analysis and Presentation. (2 Credits)
Development of skills in data and error analysis, technical communication, and scientific argument. Prerequisite: PHYS 334 and Writing and Communication Competencies.

PHYS 351. Analog Electronics. (2 Credits)
Basic principles of electronic circuits and devices. AC and DC circuit fundamentals, filters, diodes, transistors, amplifiers, and operational amplifiers. Four hours lecture, three hours laboratory. Cross-listed with ENGR 351. Prerequisite: PHYS 232. Pre or Corequisite: PHYS 334.

PHYS 352. Computer Data Acquisition. (2 Credits)
Digital electronics, analog to digital conversion, computer interfacing, and data acquisition with LabVIEW software. Four hours lecture, three hours laboratory. Prerequisite: PHYS 351. Alternate years. Course is offered occasionally.

PHYS 354. Advanced Optics. (2 Credits)
Light propagation in matter, polarization, Fourier optics, aberrations, holography, lasers, and modern optical materials and components. Four hours lecture, three hours laboratory. Alternate years. Course is offered occasionally. Prerequisite: PHYS 232.

PHYS 359. Thermodynamics. (4 Credits)
Theory of heat and gases, introduction to kinetic theory and statistical mechanics. Alternate years. Prerequisites: PHYS 232 and PHYS 334.

PHYS 361. Solid State Physics and Nanotechnology. (2 Credits)
Bonding and structure of crystals, electronic properties of insulators, semiconductors, metals, and superconductors, limits of smallness, molecular assembly, and nanoscale physics. Prerequisite: PHYS 344 or CHEM 371. Alternate years. Course is offered occasionally.

PHYS 362. Plasma Physics. (2 Credits)
Introduction to plasma physics including definition of a plasma, single particle and guiding center motions, fluid descriptions, waves, instabilities, and applications of plasma physics in space and astrophysics, controlled thermonuclear fusion, and industry. Pre or Corequisite: PHYS 342. Alternate years. Course is offered occasionally.

PHYS 363. Introduction to Medical Physics. (2 Credits)
A survey of radiation therapy, nuclear medicine, diagnostic imaging, and health physics with discussion on ethical and stewardship concerns of these technologies. Prerequisites: PHYS 222 or PHYS 331. Course is offered occasionally.

PHYS 366. Particle Physics and Cosmology. (2 Credits)
Elementary particles, fundamental interactions, conservation laws and symmetries, big bang cosmology, dark matter and dark energy. Alternate years. Prerequisites: PHYS 331 and 334. Course is offered occasionally.

PHYS 367. Introduction to Stellar and Galactic Astrophysics. (4 Credits)
Introduction to stellar and galactic astrophysics with an emphasis on the underlying physical principles. Course has an integrated lab component (2 hours lecture, 1 hour lab per week) Topics: Structure and evolution of stars, stellar atmospheres and spectra, binary stars and stellar remnants. Galactic dynamics, morphology, and evolution; large-scale structure of the universe. Prerequisites: MATH 333 and PHYS 334. Alternate years. Course is offered occasionally.

PHYS 494. Senior Seminar. (2 Credits)
Study of the wider cultural significance of physics including its historical development; its relationship to other disciplines; its philosophical interpretations; its place in a Christian worldview; and one's stewardship toward society. Independent study and classroom presentation. Prerequisite: senior standing in the major. (lin)
General Education: SHAR

PHYS 495. Independent Study. (1 to 4 Credits)
Independent research.

PHYS 496. Internship. (1 to 4 Credits)
Supervised off-campus experience with departmental approval. Graded pass/fail. Prerequisite: junior or senior standing with Physics major.

PHYS 499. Honors Thesis. (2 or 4 Credits)
An independent project providing original physics research developed in a scholarly paper and culminating in an oral examination. Partially fulfills requirements for an honors degree in physics. Additional requirements are available in the Physics Office.