

Engineering Science

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Faculty from other disciplines also support this program.

Mission Statement:

The Engineering department provides an inclusive, collaborative environment in which all students are supported in reaching their highest potential. Through experiential learning, teamwork and leadership opportunities, both in the classroom and through co-curricular activities, the program develops lifelong learning skills and ethical decision-making, and prepares students to effectively apply engineering principles to meet the evolving needs of society.

Program Educational Objectives:

Principia College's Engineering Department is committed to graduating engineers who will be:

- Practicing engineering in professional settings and/or obtaining advanced degrees in engineering or related STEM fields.
- Exceptional communicators, employing clear, concise oral and written skills.
- Exceling on a path of self-leadership/team-leadership by delivering on commitments as responsible, dedicated workers with a superior work ethic.
- Applying ethical leadership principles to their technological and professional activities and innovations.
- Contributing to the intellectual and financial growth of an organization through creative problem solving and ethical conduct, recognizing the broader implications of their engineering contributions on local, national and global levels.
- Continuing to grow professionally by obtaining advanced credentials, professional licensure and certifications, as well as serving in their professional communities.

Principia College offers a Bachelor of Science major in engineering science in the following ways:

Option I - Completion of a stand-alone four (4) year program in Engineering Science at Principia. This may be completed with coursework taken entirely at Principia.

¹**Option II** – Completion of a four to five (4 - 5) year dual degree program with Principia College and the University of North Dakota.

²**Option III** – Completion of a three (3) plus two (2) year program, where three (3) years are completed at Principia, the student will then transfer and complete two (2) years at another institution - this could include either Southern Illinois University Edwardsville (SIUE), Missouri University of Science and Technology (MST), University of Minnesota (UMN), or University of North Dakota (UND).

Successful completion of Option II awards the student a B.S. in Engineering Science from Principia College and an ABET accredited discipline specific degree

in Chemical, Civil, Electrical, or Mechanical Engineering) from the University of North Dakota. This program with the University of North Dakota allows a student to remain on the Principia College campus up to five years.

The B.S. in engineering science may also be awarded to students who opt for Option III (students usually attend Principia for three years and then transfer for their last two years) and complete the requirements below and those for an engineering degree at another university, provided that the program at the other university is approved by the director of the engineering program and transfer credit is approved by the Registrar. Also, a student will need a waiver of residency petition approved by Principia College.

All engineering students must achieve a grade of "C-" or better in ALL required science (physics, mathematics, chemistry, and computer science) and engineering courses. For students participating in the University of North Dakota Dual Degree Program, all courses transferring to UND must have a grade of "C-" or better. To complete the Engineering Science Major, a student must earn a cumulative average of 2.000 or higher for the courses (required and elective, within the department or outside it, such as math and science) taken for that program.

For UND as well as SIUE, MST, UMN, or another university, students should consult the current university bulletin and their engineering advisor about the entrance requirements for the specific engineering program they wish to pursue. The acceptance of Principia's dual degree students to the cooperating university's program is not automatic. They must apply before or during their junior year. Each university has its own timelines.

The various types of engineering programs offered as part of the dual degree with University of North Dakota (Option II) are described below.

Mechanical Engineering

The Mechanical Engineering major prepares students at all levels to effectively apply modern engineering principles to the evolving needs of industry and society through focused efforts in manufacturing, materials science, mechanical design, thermal sciences, and aerospace applications. This major supports an accessible, collaborative, multidisciplinary research and learning environment that stimulates students and faculty members to reach their highest potential through hands-on education, leadership opportunities, and life-long learning. UND offers four optional concentrations within the ABET accredited Mechanical Engineering degree.

Civil Engineering

The Civil Engineering major is concerned primarily with fundamental civil engineering design and analysis in such areas as structures, geotechnical engineering, sanitary engineering, water resources, and transportation engineering. The required curriculum includes the fundamentals for each of these areas and provides an opportunity for additional learning experiences with technical electives and a major design experience.

Electrical Engineering

The Electrical Engineering major focuses primarily on areas like Applied Electromagnetics, Power and Energy Systems, Signal and Image Processing,

Wireless Communications, and Unmanned Systems. The required curriculum includes the fundamentals for each of these areas and provides an opportunity for additional learning experiences with technical electives and a major design experience. UND offers a focus in Computer Engineering within the ABET accredited Electrical Engineering degree.

Chemical Engineering

The Chemical Engineering major prepares students to work in the chemical industry to convert basic raw materials into a variety of products, and deals with the design and operation of plants and equipment. These core principles build on the fundamentals of physical sciences and mathematics. A chemical engineer applies and uses principles of chemical engineering in any of its practical applications which include design, manufacture and operation of plants and machinery in industrial chemical (machines used to extract or convert industrial chemicals — example, crude oil) and related processes. This major in recent development has expanded to focus on new technologies such as fuel cells, hydrogen power and nanotechnology.

Other Engineering Options

Students who wish to obtain an engineering degree only from a second university (not a dual degree) should work with their engineering advisor and an advisor at the school from which they intend to graduate to match courses from our freshman and sophomore years to the requirements of the engineering school. After two years at Principia, these students would then apply to transfer their credits to that engineering school and obtain their engineering degree there. The decision to transfer Principia courses to the other school resides with the transfer institution. In addition, students may opt to complete a four-year B.S. major at the College (e.g., chemistry, computer science, mathematics, or physics) and then transfer to the university for two more years to complete an engineering degree.

¹ There is an associated fee for summer laboratories for students who declare and decide to pursue this option (Option II). This associated fee will depend on when a student declares the major and also will be discussed and approved by a Principia advisor.

² Principia College has a memorandum of understanding and/or an articulation agreement with SIUE, MST, UMN, and UND. To transfer to an institution not listed, students need to discuss their intentions for this option with the preferred institution in mind by the end of their second year with the advisor and director of the engineering program.

Departmental Learning Outcomes

Upon graduation, our students will have an ability to:

1. identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. communicate effectively with a range of audiences
4. 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

4 Engineering Science

- function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- acquire and apply new knowledge as needed, using appropriate learning strategies

Major

- B.S. Major in Engineering Science

ENGR 040 Fund of Engineering Exam Prep 0.0 SH []

This course prepares the students for The Fundamentals of Engineering Exam by providing them with the techniques and strategies of taking the FE exam, and reviewing core topics and focus areas of the exam. A practice test similar to the actual exam in terms of duration and content is offered to the students.

Class Level Restriction: Senior only.

Field of Study Restrictions: Engineering Science Majors only.

Fee=\$50.00.

ENGR 060 Engineering Seminar Non-Credit 0.0 SH []

Non-credit version of ENGR 260. The title will be extended to describe the current topic.

ENGR 101 Graphical Communications 3.0 SH []

This is a course in graphical communication, expression, and interpretation applicable to engineering, sciences, and other technology fields of study. The ability to visualize in three dimensions is developed through shape description, sketching, and multi-view projection exercises. The course includes, but is not limited to, the engineering and architectural scales, engineering lettering, geometric constructions, use of instruments, and dimensioning.

Fee=\$50.00.

ENGR 160 Intro Engineering Profession 3.0 SH [GESN]

Exploration of engineering, including fields of engineering; the engineering design process; and engineering topics such as time management, project management, CAD design, modeling, computing, fabrication, and ethical issues.

Class Level Restriction: Freshman and Sophomore only.

Fee=\$50.00.

ENGR 170 History of Technology 3.0 SH []

History of technology, including the intellectual and economic process of technological innovation, elements contributing to technological progress, the impact of such progress on the human experience, and the application of tech history to evaluating and extrapolating current trends in engineering and technology.

Fee=\$50.00.

ENGR 201 Engineering Mechanics:Statics 3.0 SH []

This course is to introduce students to some fundamental principles of the mechanics and their applications to problems of engineering. It is also geared towards helping students to thoroughly understand the presentation of the theory and its application to all disciplines of engineering as one decides to choose (civil, mechanical, electrical, computer, etc.) and stimulate an interest in engineering.

Prerequisite: MATH 182 (may be taken concurrently) and PHYS 201.

Fee=\$50.00.

- ENGR 202 Engineering Mechanics:Dynamics** **3.0 SH** []
 This course is an application of the fundamental concepts of mechanics, including resultants of force systems, free-body diagrams, equilibrium of rigid bodies, and analyses of structures as studied in ENGR 201.
Prerequisite: PHYS 201, MATH 182, and ENGR 201.
Fee=\$50.00.
- ENGR 203 Mechanics of Materials** **3.0 SH** []
 This course is the branch of mechanics that deals with the relationship between external loads and reactions and the intensities of the internal loads within a deformable body. For the design of a structure or verification of the safety of an existing structure, it is necessary to determine the forces acting on and within the structural members.
Prerequisite: ENGR 201 and MATH 284 (may be taken concurrently) with a grade of C- or better in both courses.
Fee=\$50.00.
- ENGR 204 Mech. Engr. Student Design** **3.0 SH** []
 This course familiarizes students with the operation and safety of machine tools. This gives students knowledge of what goes into engineering designs in building a prototype and also enables them to operate shop machinery as a part of future courses.
Prerequisite: ENGR 101.
Fee=\$50.00.
- ENGR 205 Chem Engineering Fundamentals** **3.0 SH** []
 Introduction to principles of stoichiometry using material and energy balances within chemical processes.
Prerequisite: CHEM 131.
Fee=\$50.00.
- ENGR 206 Elect. Engr. Circuit Analysis** **4.0 SH** []
 This lab course introduces fundamental circuit analysis for EE or other engineering majors. Topics include Ohm's Law, KCL, KVL, mesh and node-based circuit analysis, op amps, RLC circuits, sinusoidal analysis and phasors, and three-phase power. Emphasis on intuitive circuit comprehension using equivalences, superposition, etc. Lab activities emphasize both simulated and physical circuits.
Prerequisite: MATH 181 with a grade of C- or better.
Fee=\$50.00.
- ENGR 242 3-D Printing Technology** **4.0 SH** [GESL]
 This course provides an overview of open-source hardware in theory and practice. Students will learn, and put into practice, the practical sustainability applications of open-source hardware. In a progressive series of projects each student will build their own open-source printer and design objects, using open-source software, for sharing with makers in underdeveloped countries.
Class Level Restriction: Junior and Senior only.
Fee=\$150.00.
- ENGR 260 Engineering Seminar** **1.0 SH** []
 Topics will vary based on the needs and interests of the students and instructor, and the title will be extended to describe the current topic. May be taken eight times up to a total of eight semester hours provided the topics differ.
Prerequisite: ENGR 160.
Fee=\$50.00.
- ENGR 262 Computer Hardware Architecture** **5.0 SH** []
 Digital electronic logic explored in theory and laboratory from simple switching to electronic architecture of digital computers. Topics include electronic valving and switching, logic-gate design, Boolean algebraic proofs of gate equivalence, counters, registers, arithmetic, operations, memory addressing and information transfer, microprogramming, interfacing and control.
Prerequisite: CSCI 171 with a grade of C or better.
Fee=\$50.00.

- ENGR 264 Embedded Systems** **4.0 SH** []
 Design and construction of embedded software and hardware, including device drivers, I/O bus protocols, digital card design, and low-level debugging.
Prerequisite: CSCI 263 and ENGR 262.
Fee=\$50.00.
- ENGR 280 Engineering Projects** **1.0-6.0 SH** []
 A hands-on course that allows students to learn vital lessons through active participation in a project. Topics may vary between offerings and are chosen according to needs and interests of students and instructor. The title will be extended to describe the current topic. May be offered for variable credit from one to six semester hours. May be taken eight times up to a total of 48 semester hours regardless of the topic.
- ENGR 301 Materials Science** **3.0 SH** []
 An introduction to the theory of the structure of matter, as well as the prediction and evaluation of engineering properties of materials, using a combination of real-life examples, theoretical explanations, and demonstrations. An overview of material structures, atoms, bonding, and crystalline structures precedes the study of mechanical behavior and failure analyses of various classes of materials: metals, ceramics, etc.
Prerequisite: ENGR 203 with a grade of C- or better.
Class Level Restriction: Junior and Senior only.
Fee=\$50.00.
- ENGR 306 Fluid Mechanics** **3.0 SH** []
 Fluid properties; fluid statics and dynamics; transport theory and transport analogies, conservation of mass, energy, and momentum; dimensional analysis; boundary layer concepts; pipe flows; compressible flow; open channel flow.
Prerequisite: MATH 283 and PHYS 201 with a grade of C- or better in both courses.
Class Level Restriction: Junior and Senior only.
Fee=\$50.00.
- ENGR 313 Linear Electric Circuits** **4.0 SH** []
 Building on concepts from ENGR 206, this course covers linear electric circuits in the steady state and transient conditions, including two-port circuit models, and use of Fourier series to analyze single and polyphase systems. Laboratory component includes physical and simulated experiments with linear circuits.
Prerequisite: ENGR 206 with a grade of C- or better.
Class Level Restriction: Sophomore and Junior and Senior only.
Fee=\$50.00.
- ENGR 314 Signals and Systems** **4.0 SH** []
 Passive filters; Laplace transform applications; Fourier transform; Z-transform; Nyquist sampling theorem; other topics as time permits (e.g. state variables; introduction to control and communications theory).
Prerequisite: ENGR 313 with a grade of C- or better and MATH 284.
Class Level Restriction: Junior and Senior only.
Fee=\$50.00.
- ENGR 322 Design of Machinery** **3.0 SH** []
 The course introduces the students to the design of mechanisms. Students will develop the ability to solve real, unstructured mechanism design problems. The skills learned in Statics and Dynamics, are enhanced in the area of Mechanisms Design. The students learn to synthesize and analyze mechanisms using analytical approach and modern engineering analysis and simulation tools such as MATLAB.
Prerequisite: CSCI 171 and ENGR 202 both with a grade of C- or above.
Class Level Restriction: Junior and Senior only.
Fee=\$50.00.

- ENGR 323 Machine Component Design** **4.0 SH** []
 Design of machine elements such as shafts, bearings, gears, clutches, springs, threaded components, and bolted, riveted, welded, and bonded joints. Stress and failure theory analyses of the implementation of machine components are covered. Laboratory emphasizes creative design, analysis techniques, construction methods, and design report writing.
Prerequisite: ENGR 203 with a grade of C- or better.
Class Level Restriction: Junior and Senior only.
Fee=\$50.00.
- ENGR 340 Prof Integrity in Engineering** **3.0 SH** []
 This course emphasizes the need for technical professionals to develop personal integrity and moral character in order to benefit society. Students will develop an appreciation for the global context of their decisions, the ability to make sound ethical decisions, and communicate their ideas effectively. This course also explores the impact of engineering and applied science on society.
Class Level Restriction: Junior and Senior only.
Fee=\$50.00.
- ENGR 351 Structural Mechanics** **3.0 SH** []
 Structural Mechanics is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, vehicles, machinery, and furniture. Structural analysis incorporates the fields of applied mechanics, materials science and applied mathematics to compute a structure's characteristics (reactions and stability).
Prerequisite: ENGR 201 and ENGR 203 with a grade of C- or better in both courses.
Class Level Restriction: Junior and Senior only.
Fee=\$50.00.
- ENGR 400 Internship** **1.0-2.0 SH** []
 This course is designed for a student to obtain practical experience in the field of engineering. The student will be working for an organization putting into practice content, theories, and skills in the major. Offered on an independent contract basis.
Class Level Restriction: Sophomore and Junior and Senior only.
Field of Study Restrictions: Engineering Science Majors only.
Fee=\$50.00.
- ENGR 410 Underwater Vehicle Design** **4.0 SH** []
 This course will cover the design, construction and operation of a computer controlled underwater vehicle designed for a specific underwater mission. Course work will include key issues involved in operation of u/w vehicles including task specific instrumentation, as well as positioning and navigational systems. Coursework may optionally follow MATE's design challenge and competition for a given year.
Prerequisite: ENGR 280 and ENGR 204 or ENGR 206.
Class Level Restriction: Junior and Senior only.
Field of Study Restrictions: Engineering Science Majors only.
Fee=\$50.00.
- ENGR 442 Open Source Hardware** **4.0 SH** []
 This course provides in depth experience with open-source electronics and hardware. The technological evolution of the open-source 3-D printing technology will be covered with a focus on innovating for improved design and performance. Each student will build a Jellybox including all electronics, hardware, firmware, slicing and printer controller software followed by completing an in-depth customization project related to the Jellybox.
Class Level Restriction: Junior and Senior only.
Fee=\$290.00.

ENGR 499 Senior Design Project

1.0-4.0 SH []

This comprehensive design course integrates engineering design and engineering science components into a major design experience. It is a culminating major project that incorporates appropriate engineering standards and multiple constraints, and is based on the knowledge and skills acquired in earlier course work. Design reports and individual oral presentations required.

Prerequisite: ENGR 340.

Class Level Restriction: Senior only.

Field of Study Restrictions: Engineering Science Majors only.

Fee=\$50.00.