

### Summary of Undergraduate and Graduate Majors by Department

Undergraduate Majors	Graduate Majors
<b>Aerospace Engineering (AerE)</b>	
- Aerospace Engineering	- Aerospace Engineering (MEng, MS, PhD) - Engineering Mechanics (MEng, MS, PhD)
<b>Agricultural and Biosystems Engineering (ABE)</b>	
- Agricultural Engineering - Biological Systems Engineering - Agricultural Systems Technology* - Industrial Technology* * Technology degrees offered through ABE	- Agricultural & Biosystems Engineering (MEng, MS, PhD) - Industrial & Agricultural Technology (MS, PhD)*
<b>Chemical and Biological Engineering (CBE)</b>	
- Chemical Engineering	- Chemical Engineering (MEng, MS, PhD)
<b>Civil, Construction &amp; Environmental Engineering (CCEE)</b>	
- Civil Engineering - Construction Engineering - Environmental Engineering	- Civil Engineering (MEng, MS, PhD)
<b>Electrical and Computer Engineering (ECpE)</b>	
- Computer Engineering - Cyber Security Engineering - Electrical Engineering - Software Engineering	- Computer Engineering (MEng, MS, PhD) - Electrical Engineering (MEng, MS, PhD)
<b>Industrial and Manufacturing Systems Engineering (IMSE)</b>	
- Industrial Engineering	- Industrial Engineering (MEng, MS, PhD)
<b>Materials Science and Engineering (MSE)</b>	
- Materials Engineering	- Materials Science & Engineering (MEng, MS, PhD)
<b>Mechanical Engineering (ME)</b>	
- Mechanical Engineering	- Mechanical Engineering MEng, MS, PhD)
<b>Minors and Interdepartmental Graduate Programs</b>	
<b>Engineering Minors</b> - Bioengineering - Energy Systems - Engineering Sales - Nondestructive Evaluation - Nuclear Engineering <b>Interdisciplinary Minors</b> - Entrepreneurial Studies - Sustainability - Wind Energy	<b>Interdepartmental Graduate Programs</b> - Bioinformatics & Computational Biology (PhD) - Biorenewable Resources & Technology (MS, PhD) - Engineering Management (MEng) - Environmental Science (MS, PhD) - Human-Computer Interaction (MS, PhD, & Cert) - Information Assurance (MS, PhD) - Sustainable Agriculture (MS, PhD) - Systems Engineering (MEng) - Toxicology (MS, PhD) - Transportation (MS) - Wind Energy Science (PhD)

# Departments and Degree Programs

## The Department of Aerospace Engineering (AerE)

### Aerospace Engineering (BS, MEng, MS, PhD)

Aerospace engineers are primarily interested in the design, analysis, testing, and overall operation of vehicles and systems that operate in air, water, and space. The ISU curriculum is designed to provide the student with an education in the fundamental principles of aerodynamics, flight dynamics, propulsion, structural mechanics, flight controls, design, testing, and space technologies. In addition to core engineering courses, AerEs take classes in dynamics (forces on moving objects), thermodynamics (heat movement), flight structures, flight controls, propulsion, and aerospace materials. Some electives include: astrodynamics, wind energy, composites, wind energy, and spacecraft systems.

### Engineering Mechanics (MEng, MS, PhD)

Engineering mechanics students acquire an understanding of the basic principles and analysis techniques pertaining to the static and dynamic behavior of rigid media, deformable solids, fluids, and gasses. Physical properties of engineering materials are studied and tested in the laboratory.

*Research focus areas for the AerE Department include: Advanced Materials; Aerodynamics, Combustion and Aero-Structural Interaction; Asteroid Deflection; Aviation Biofuels; Complex Systems and Optimization; Guidance, Controls, Astrodynamics and Space Systems; Non-destructive Testing and Evaluation.*

## The Department of Agricultural and Biological Systems Engineering (ABE)

### Agricultural Engineering (BS, MEng, MS, PhD)

Agricultural engineering graduates contribute to the analysis and design of machinery, animal housing, and environmental systems for the production, processing, storage, handling, distribution, and use of food, feed, fiber and other biomaterials. They also focus on the management of related natural resources. At ISU, agricultural engineering students can specialize in one of the following three areas:

- **Animal Production Systems** focuses on ensuring sustainable development of livestock and poultry industries.
- **Land and Water Resource** focuses on developing solutions and best management practices that protect and conserve the soil and water resources.
- **Power and Machinery** focuses on engineering new technologies and systems which enhance the productivity, efficiency, and performance of advanced machinery and manufacturing systems.

### Biological Systems Engineering (BS)

Biological systems engineering graduates integrate life sciences with engineering to solve problems related to biological systems. These biological systems may include microbes, plants, animals, humans and/or ecosystems. Biological systems engineers use their understanding of engineering to analyze organisms or ecosystems, and their knowledge of biological systems to inspire and inform their designs. Biological systems engineering design may include developing processes and systems that monitor, simulate, replace, modify, control, optimize, or utilize the mechanisms of living organisms and their products. The BSE program has the following four options:

- **Biorenewable Resources** focuses on understanding the economics, environmental impacts, and sustainability of biorenewable resource production systems, biomass-derived fuels, and processing of biomass for energy and/or chemicals.
- **Bioenvironmental** focuses on the biology and engineering principles relevant to soil, water, and air quality.
- **Food** focuses on the science and engineering needed to design and operate food processing systems.
- The **Pre-Professional and Pre-Graduate Option** provides a springboard into other professions – from science (via MS or PhD) to medicine and law.

*Research focus areas for the ABE Department include: Advanced Machinery Engineering and Manufacturing Systems; Animal Production Systems Engineering; Biological and Process Engineering and Technology; Occupational Safety Engineering; and Land and Water Resources Engineering*

## The Department of Chemical and Biological Engineering (CBE)

### Chemical Engineering (BS, MEng, MS, PhD)

Chemical engineering students apply the physical sciences (e.g., chemistry and physics) and/or life sciences (e.g., biology, microbiology and biochemistry) to processes that convert raw materials or chemicals into more useful forms. In addition, chemical engineers develop new materials and related techniques that are often essential to related fields such as nanotechnology, fuel cells and biomedical engineering. Since chemical engineering is a very diverse field, the ISU program is flexible so students can tailor their coursework to match their interests. Core courses include Chemical Reaction Engineering, Chemical Thermodynamics, Separations, Transport Phenomena, Material & Energy Balance, Process Control, and Process and Plant Design.

Some chemical engineering students enhance their academic preparation for the growing opportunities in the biological-related industries by adding the biological engineering option to the standard chemical engineering program. The Biological Engineering Option includes electives in Biochemistry, Genetics, and Physiological Chemistry.

*Research focus areas for the CBE Department include: Advanced and Nanostructured Materials; Biorenewables; Catalysis and Reaction Engineering; Computational Fluid Dynamics; Health Care Technology and Biomedical Engineering; and Renewable Energy*

## The Department of Civil, Construction, and Environmental Engineering (CCEE)

### Civil Engineering (BS, MEng, MS, PhD)

Civil engineers are primarily interested in the design, construction, and maintenance of works like roads, bridges, canals, dams, and buildings. While the interests of civil engineers are often focused on the civil structures, their design and analysis skills are often used in the engineering of structures in other industries. The CE curriculum is focused on breadth and students can choose one of the following areas of emphasis:

- **Environmental** focuses on systems and structures for removing contaminants from water, reducing nonhazardous solid waste volumes, eliminating pollutants from the air, and developing water supplies.
- **Geotechnical** focuses on developing projects below ground level and determining ways to stabilize soil and support structures on and in the ground.
- **Structural** focuses on designing structures that can withstand design loads including those from wind, temperature changes, earthquakes, and other forces.
- **Transportation** focuses on determining ways to meet the travel needs of people and goods on land, air, and water.

### Construction Engineering (BS)

The ISU Construction Engineering Program is the largest and one of only seven ABET accredited programs in the U.S. Construction engineers focus on the planning and execution of the designs and are a cross between a civil engineer and a construction manager. The areas of emphasis for ISU construction engineering include:

- **Heavy/Highway Construction**
- **Building Construction**
- **Mechanical Construction**
- **Electrical Construction**

### Environmental Engineering (BS)

Undergraduate students in the environmental engineering bachelor's degree program will complete a curriculum covering the engineering and science knowledge necessary to design and implement effective, affordable solutions for environmental challenges involving water, air and land. Graduates of this program will be prepared to work in environmental engineering positions within the private and public sectors that deal with pollution and contamination in all aspects of the built and natural environment.

*Research focus areas for the CCEE Department include: Construction Engineering and Management; Environmental/Water Resources Engineering; Geotechnical/Materials Engineering; Structural Engineering; Transportation Engineering; and Intelligent Infrastructure Engineering*

## **The Department of Electrical and Computer Engineering (ECpE)**

### **Computer Engineering (BS, MEng, MS, PhD)**

Computer engineers integrate several fields of electrical engineering and computer science to design and develop computer systems and networks. Computer engineers commonly work on the design of individual circuits, microprocessors, personal computers, and supercomputers. Tasks often involve designing VLSI chips, sensors, mixed signal circuit boards, and operating systems; and writing software and firmware for computers and controllers. Computer engineers are key contributors to the development of automation/robotic systems, which integrate sensors, communications, decision making and motor control. The ISU program is also particularly strong in the areas of information and networking technology.

### **Cyber Security Engineering (BS)**

Cyber Security engineers protect computer and networking systems from potential hackers and cyber-attacks. This major was first offered in 2019 but Iowa State has been teaching and researching cyber security since 1995, making it one of the oldest programs in the country. Students gain a strong foundation in computer engineering concepts while applying engineering methodology to solve complex cyber security problems.

### **Electrical Engineering (BS, MEng, MS, PhD)**

Electrical engineers focus on large and small electrical and electromagnetic applications. The electrical engineering curriculum offers a number of emphasis areas at the undergraduate level, including control systems, microelectronics and photonics, VLSI, electric power and energy systems, and communications and signal processing, and electromagnetics and nondestructive evaluation. Students are required to choose at least one course sequence that focuses on one of these areas and students may also take elective courses in computer networking, security, computer architecture, digital systems, and software.

### **Software Engineering (BS)**

Software engineers focus on the designing, implementing, and maintaining software systems that are reliable, efficient, and affordable. Software engineers also work in application design, which involves designing or coding new programs and applications to meet a specific need. The software engineering curriculum is jointly administered by the Department of Computer Science and Department of Electrical and Computer Engineering. Iowa State University is one of the few universities in the nation to offer a software engineering degree with courses in both computer science and computer engineering.

*Research focus areas for the ECpE Department include: Bioengineering; Cyber Infrastructure; Data, Decisions, Networks & Autonomy; Energy Infrastructure; and Materials, Devices, and Circuits*

## **The Department of Industrial and Manufacturing Systems Engineering (IMSE)**

### **Industrial Engineering (BS, MEng, MS, PhD)**

Industrial engineers design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and energy. Industrial engineers often focus on issues related to human factors, operations research, engineering management, manufacturing engineering, and quality. Industrial engineers often work to optimize complex processes or systems. At the undergraduate level, students can choose a set of electives in one of the following focus areas:

- **Engineering Management** focuses on the strategies necessary for solving internal and external problems of a company in areas such as production, quality, project management, sales, and marketing strategies.
- **Human Factors** focuses on the relationships between people and their work tasks, machines, information, and environment.
- **Operations Research** focuses on making engineering decisions using quantitative models and methods for production and service systems such as, inventory control, scheduling, transportation, and logistics.

- **Manufacturing Systems** focuses on the design, analyze, operate, and control processes and systems.
- **Enterprise Informatics** focuses on the integration and use of information from the functional units of an enterprise as well as between multiple enterprises.

*Research focus areas for the IMSE Department include: Operations Research and Analytics; Advanced Manufacturing; Human Factors and Ergonomics; and Systems Engineering and Engineering Management.*

**Systems Engineering (MEng)** – See the Interdepartmental Graduate Programs section for a description of this major that is closely associated with the IMSE Department.

## The Department of Materials Science and Engineering (MSE)

### Materials Engineering (BS)

Materials engineers understand the relationship between the structure of materials at atomic or molecular scales and their macroscopic properties. The materials engineering coursework encompasses all four of the major elements of materials science and engineering, which includes synthesis and processing, structure, properties, and applications of materials. Undergraduate students choose a minimum of two areas of specialization, which include:

- **Ceramics**
- **Electronics**
- **Metals**
- **Polymers**

### Materials Science and Engineering (MEng, MS, PhD)

The MSE graduate program is built on a foundation of thermodynamics, kinetics of phase transformations, mechanical behavior, physical properties, solid state science, and the structure and chemistry of materials. Advanced studies are offered in many areas of materials science and engineering, including the design and control of materials for structural, electronic, photonic, magnetic, optical, and biological functionality. The department awards M. Engr., M.S., and Ph.D. degrees in Materials Science and Engineering. An opportunity to complete and obtain a certificate in Nondestructive Evaluation (NDE) is also an option for students. The M.S. and Ph.D. programs are highly flexible and research-oriented, where students work closely with their major professor in tailoring the various academic and research components to match their interests.

*Research focus areas for the MSE Department include: Advanced manufacturing processes; Biomaterials and bio-inspired materials; Functional materials and physical behavior; Materials for energy technologies; Nanomaterials and coatings; Novel phases, structures, and transformations; Rare earth metals and other critical materials; Structural materials, composites, and hybrids.*

## The Department of Mechanical Engineering (ME)

### Mechanical Engineering (BS, MEng, MS, PhD)

Mechanical engineering involves the production and usage of heat and mechanical power for the design, production, and operation of machines and tools. Mechanical engineers apply the principles of physics and materials science for analysis, design, manufacturing, and maintenance of mechanical systems. After completion of the basic engineering program, the mechanical engineering core curriculum is designed to provide undergraduate students exposure to each of the four major areas in the field:

- **Design and Optimization**
- **Materials and Manufacturing**
- **Thermal Fluids**
- **Dynamic Systems**

### Energy Systems Engineering (MEng)

The Energy Systems degree offers students an opportunity to research energy challenges facing the 21st century. Through the research of providing sustainable energy for the world's growing population, students acquire the knowledge, skills and ability to effectively design, evaluate, construct and manage energy systems.

*Research focus areas for the ME Department include: Health (Bioengineering, Translational Health); Fluids (Multiphase, Complex); Multi-scale Engineering (Design, Manufacturing, Nanoscale Sciences); Systems (Dynamics, Sensors, Controls); Computational Sciences (Big Data, Visualization); and Energy (Energy Sciences, Sustainability).*

## **Interdepartmental Graduate Programs**

### **Bioinformatics and Computational Biology (PhD)**

This program is one of the largest such PhD programs in the nation. Students have the opportunity to conduct research in all major research areas of computational molecular biology, including genomics, structural genomics, functional genomics, and computational systems biology. Students train in a highly interdisciplinary environment under faculty with expertise spanning both computational and life sciences, with access to some of the most modern experimental platforms. [CBE, ECpE, MSE]

### **Biorenewable Resources and Technology (MS, PhD)**

This first in the nation graduate program in biorenewable resources and technology (BRT) offers students advanced study in the use of plant- and crop-based resources in the production of biobased products (fuels, chemicals, materials, and energy). This program offers minor and co-major MS and PhD degrees. The BRT program also offers a 12-credit hour online graduate certificate that provides students from a wide variety of science and engineering backgrounds an exposure to advanced study in biorenewables. [ABE, CBE, CCEE, ME]

### **Engineering Management (MEng)**

This program prepares engineers for leadership/management positions within their organizations. The program gives students the knowledge and skills necessary to manage and develop a highly qualified and trained staff of engineers, scientists, and technicians in a rapidly changing technological environment. Engineering Management is a unique discipline that uses engineering skills and knowledge in managing large scale projects. [All]

### **Environmental Science (MS, PhD)**

This program provides a rigorous, quantitative, and integrated approach to the study of environmental systems. Given the magnitude and complexity of our environmental problems, there is a growing need for graduates trained in the integrated analysis of environmental systems. The environmental science curriculum is designed to prepare students for positions of leadership in this rapidly changing field. Students are afforded a broad exposure to the biological, chemical, and physical aspects of environmental systems and the specialized training necessary for integrated analyses of these systems. [ABE, CCEE]

### **Human-Computer Interaction (MS, PhD)**

Driven by unprecedented technological progress, the relationship between humans and increasingly powerful, portable, interconnected, and ubiquitous computers is fast becoming one of the most dynamic and significant fields of technical investigation. With more than 60 researchers, representing all the colleges in the university, Iowa State is expanding its focus to become a leader in HCI research. [AerE, ABE, CCEE, ECpE, IMSE, ME]

### **Information Assurance (MS)**

The Information Assurance Program prepares highly-qualified engineers, computer science experts, and information systems professionals for information security and assurance careers. Information assurance has become a critical issue for businesses as they encounter problems from external network attacks as well as internal issues due to lax control systems and compliance requirements. Iowa State University is recognized as one of the Centers of Academic Excellence in Information Assurance education. [ECpE, IMSE]

### **Sustainable Agriculture (MS, PhD)**

Students in this program study agroecological principles and the social relations underlying sustainable farming and food systems while gaining practical experience with sustainable production methods. The program seeks to balance depth in disciplinary knowledge with broader, systems-level thinking. It integrates the technical and social sciences

through a sequence of team-taught interdisciplinary courses emphasizing higher-order critical thinking skills and active, collaborative approaches to learning. [ABE, CCEE, IMSE]

### **Systems Engineering (MEng)**

The Systems Engineering Program is designed to enable engineers, regardless of undergraduate discipline, to develop the analytical abilities needed to design, evaluate, and build complex systems involving many components and demanding specifications. This program is designed to train engineers to excel in the technology driven design environment commonly found in developing modern complex engineered systems. The intent of this program is to extend the ability of engineers to work across disciplinary boundaries as needed. [All]

## **Related Technical Majors**

### **College of Agriculture and Life Sciences**

#### **Agricultural Systems Technology (BS) – Administered by the ABE Department**

Agricultural Systems Technology (AST) graduates focus on managing, using, and troubleshooting technology by applying their knowledge of technology, agriculture, and processing systems. The hands-on curriculum in the College of Agriculture and Life Sciences teaches students to manage machines and equipment, biological processes, computers and other technologies to create new and improved agricultural systems for the future. Students majoring in Agricultural Systems Technology choose between two options:

- Agricultural and Biosystems Management
- Machine Systems

#### **Industrial Technology (BS) – Administered by the ABE Department**

The Industrial Technology curriculum blends comprehensive general education courses and extensive laboratory experience with manufacturing processes. Strong emphasis is placed on computer applications, resource allocation, safety, and product quality. The following options permit students to specialize in subject areas:

- The **Manufacturing** option prepares graduates to plan and coordinate materials, machines, methods, and human resources in a manufacturing environment.
- The **Occupational Safety** option prepares graduates to develop, coordinate, and evaluate the safety issues relating to people, materials, equipment, methods, and environments.

#### **Industrial and Agricultural Technology (MS, PhD) – Administered by the ABE Department**

Industrial and Agricultural Technology is a MS and PhD graduate program that focuses on technology systems for industry, agricultural, and public sectors. The PhD program focuses on preparing the next generation of faculty for a broad sector of technology related disciplines.

### **College of Liberal Arts and Sciences**

#### **Computer Science (BS, MS, PhD)**

Computer science majors are prepared for a career in the computer and information sciences industry. They are provided with a strong background in the fundamentals of computing, algorithms, programming, languages, databases, computer systems, and software engineering. Computer science majors often explore advanced topics in several areas including artificial intelligence, machine learning, robotics, databases, information systems, and parallel & distributed computing.