

A Brief Guide to Engineering Majors



While you can earn a college degree in “General Engineering,” the vast majority (about 98%) of all engineering bachelor’s degrees are awarded in a specific field (discipline) of engineering. Thus, it is important to have a specific engineering discipline(s) in mind when evaluating schools (and many schools will ask (or require) that you specify a particular discipline when you apply for admissions, although there is usually some flexibility granted students to transfer from one discipline to another, typically after the first (freshman) year of studies).

Based on the number of bachelor’s degrees awarded annually, the engineering majors offered at U.S. colleges and universities can be roughly divided into one of four size-based categories:

- **The “Big Four” Disciplines:** Civil, Computer, Electrical, and Mechanical Engineering, which together collectively account for approximately two-thirds (67%) of all engineering bachelor’s degrees awarded annually.
- **The “Medium Four” Disciplines:** Aerospace, Biomedical, Chemical, and Industrial/Manufacturing Engineering, which collectively account for approximately 20% of all engineering bachelor’s degrees awarded annually.
- **The “Smaller Ten” Disciplines:** Agricultural, Architectural, Engineering Management, Engineering Physics/Engineering Science, Environmental, General Engineering Studies, Materials, Mining, Nuclear, and Petroleum Engineering, which collectively account for less than 10% of all engineering bachelor’s degrees awarded annually.
- **The Specialty Disciplines:** A variety of specialty disciplines offered (such as Ocean Engineering) that collectively account for less than 5% of all engineering bachelor’s degrees awarded annually.

Brief summaries of individual engineering disciplines are provided below. For more information, see:

- Engineering Education Service Center (www.EngineeringEdu.com)
- JETS (Junior Engineering Technical Society) (www.jets.org)
- Engineering K-12 Center (www.engineeringk12.org)
- Sloan Career Cornerstone Center (www.careercornerstone.org)

AEROSPACE ENGINEERING (AeroE)

Overall Focus: Flight vehicles and systems, covering both space flight (spacecraft, rockets, satellites, etc.) and sub-space flight (airplanes, helicopters, missiles, etc.). Many Aerospace Engineers also work on land-based vehicles as well (race cars, regular cars, etc), typically focusing on aerodynamics (designing external surfaces)

Related Fields: Astronautical Engineering (focusing just on space flight) and Aeronautical Engineering (focusing just on sub-space flight). Most offered academic programs are in Aerospace Engineering.

Primary Areas of Specialization:

1. Aerodynamics (design of external surfaces)
2. Structural Design & Materials Selection
3. Propulsion Systems
4. Guidance & Control Systems

Associated Professional Society: American Institute of Aeronautics and Astronautics (AIAA) (www.aiaa.org)

AGRICULTURAL ENGINEERING (AgE)

Alternative Names: Biological Engineering; Biological Systems Engineering; Biosystems Engineering.

Overall Focus: Production and processing of agricultural products (“agriculture” = crops, livestock and poultry).

Primary Areas of Specialization:

1. Agricultural Equipment & Technology (tractors, harvesters, animal feeding systems, crop irrigation systems, etc.)

2. Agricultural Product Handling/Processing Equipment (to clean, sort, dry, package, etc.)
3. Biotechnology (as specifically applied to agriculture)
4. Land and Water Management (irrigation systems, erosion control, pesticide/fertilizer use/management)
5. Storage Structures (housing of farm animals and farm products)

Associated Professional Society: American Society of Agricultural & Biological Engineers (ASAE) (www.asabe.org)

ARCHITECTURAL ENGINEERING (ArchE)

Overall Focus: “Engineered systems” (that is, structural, mechanical, and electrical systems) for commercial, industrial, and institutional buildings/facilities. Overall, Architectural Engineers seek to “bridge the gap” between Architects (who focus on “form and function”) and Engineers (who focus on “buildability”) in designing/building buildings and facilities.

Core Curriculum Areas:

1. Structural Systems
2. Mechanical and Electrical Systems (including power systems, communications and control systems; lighting systems; and heating, ventilation, and air conditioning (HVAC) systems)
3. Construction/Construction Management

Associated Professional Society: Architectural Engineering Institute (AEI) (www.aeoinstitute.org)

BIOENGINEERING (BioE)

See “Biomedical Engineering”

BIOLOGICAL / BIO-RESOURCES / BIO-SYSTEMS ENGINEERING

See “Agricultural Engineering”

BIOMEDICAL ENGINEERING (BiomedE)

Alternative Name: Bioengineering

Overall Focus: Engineering applications within the broad fields of medicine and the life sciences.

Primary Areas of Specialization:

1. Biomaterials (both living tissue and artificial materials used in implantation applications)
2. Biomechanics (applying classic engineering mechanics principles to medical problems and/or to gain a better understanding of living things.)
3. Biotechnology (focusing on the development and production of pharmaceutical products – drugs, etc.)
4. Clinical Engineering (overall use of technology for health care in hospitals)
5. Medical Devices/Equipment (including diagnostic units (x-ray, CAT scan, MRI, etc.), treatment devices (for surgery, etc.), and prosthetics)

Associated Professional Society: Biomedical Engineering Society (BES) (www.bmes.org)

CERAMICS ENGINEERING (CerE)

See “Materials Engineering”

Associated Professional Society: National Institute of Ceramic Engineers (NICE), part of the American Ceramic Society (www.ceramics.org)

CHEMICAL ENGINEERING (ChemE)

Overall Focus: Chemical-based manufacturing - applying chemistry for commercial-quantity production of a wide variety of products, including:

- Fuels (gasoline, natural gas)
- Petro-Chemicals (chemicals obtained from petroleum or natural gas)
- Agricultural Chemicals (fertilizers, pesticides)
- Industrial Chemicals (acids, alkalis, organics, salts)
- Plastics, Polymers and Fibers
- Paper and Paper Products
- Pharmaceuticals and Drugs
- Consumer Products (paints, soaps, household cleaners, etc.)
- Food Additives/Products
- Advanced Materials (ceramics, electronic materials, composites, etc.)

Primary Areas of Specialization:

1. Biotechnology (including for agricultural, food, medical, and industrial applications)
2. Environmental Engineering (see separate entry)
3. Petroleum and Natural Gas (refine crude oil and natural gas)
4. Polymers (focusing on the production of polymeric materials - plastics, synthetic rubbers and fibers, films and composite materials; a specialty area of Materials Engineering – see separate entry)
5. Process Control Systems (for managing and optimizing the operation of large-scale, chemical-based industrial operations).

Associated Professional Society: American Institute of Chemical Engineers (AIChE) (www.aiche.org)

CIVIL ENGINEERING (CE)

Overall Focus: “Public works”/infrastructure and buildings/structures.

Note: Given the number of potential applications, Civil Engineering is a very broad discipline.

Primary Areas of Specialization:

1. Construction Management (combining engineering and management skills to complete construction projects designed by other engineers and architects).
2. Environmental Engineering (see separate entry)
3. Geotechnical Engineering (analysis of soils and rock in support of engineering projects/applications - building foundations, earthen structures, underground facilities, dams, tunnels, roads, etc)
4. Structural Engineering (design of all types of stationary structures - buildings, bridges, dams, etc.)
5. Surveying (measure/map the earth’s surface in support of engineering design and construction projects and for legal purposes - locating property lines, etc.)
6. Transportation Engineering (design of all types of transportation facilities/systems – streets/highways, airports, railroads, other mass transit, harbors/ports, etc.).
7. Water Resources Engineering (control and use of water, focusing on flood control, irrigation, raw water supply, and hydroelectric power applications)

Associated Professional Society: American Society of Civil Engineers (ASCE) (www.asce.org)

COMPUTER ENGINEERING (CompE)

Overall Focus: Utilize knowledge in both Computer Science and Electrical Engineering to design integrated computer systems (that is, integrating hardware and software components).

Primary Areas of Specialization:

1. Artificial Intelligence (developing computers that simulate human learning and reasoning abilities)
2. Computer Architecture (designing new computer instruction sets, and combining electronic or optical components to yield powerful computing systems)
3. Computer Design and Engineering (designing new computer circuits, microchips, and other electronic computer components)
4. Computer Theory (investigating the fundamental theories of how computers solve problems, and applying the results to other areas of computer engineering)
5. Information Technology (developing and managing information systems that support a business or other organization)
6. Operating Systems and Networks (developing the basic software computers use to supervise themselves or to communicate with other computers)
7. Robotics (designing computer-controlled robots for performing repetitive industrial tasks)
8. Software Applications (applying computing software to solve problems outside the computer field - in education or medicine, for example).
9. Software Engineering (generating computer programs)

Associated Professional Society: Institute of Electrical & Electronics Engineers (IEEE) Computer Society (www.computer.org)

COMPUTER SCIENCE (CS)

Note: While technically not an engineering discipline, CS is an integral part of Computer Engineering, while a significant number of stand-alone CS academic programs are offered within engineering schools.

Overall Focus: A science-based approach to computer systems, emphasizing underlying math and general theory.

Core Curriculum Areas:

1. Algorithms
2. Computer Organization and Architecture
3. Data Structure
4. Programming Languages
5. Software Design

Associated Professional Society: Association for Computing Machinery (ACM) (www.acm.org)

CONSTRUCTION MANAGEMENT/ENGINEERING (ConE)

See “Construction Management” under “Civil Engineering”

Associated Professional Society: American Society of Civil Engineers (ASCE) (www.asce.org)

ELECTRICAL ENGINEERING (EE)

Overall Focus: All things electrical/electronic – electronic devices, electrical systems, electrical energy, etc.

Note: Given the number of potential applications, Electrical Engineering is a very broad discipline.

Primary Areas of Specialization:

1. Communications (transmission and processing of information via various means - wires, cable, fiber optics, radio, satellite, etc.)
2. Computer Engineering (see separate entry)
3. Digital Systems (digital-based communication and control systems)
4. Electric Power (generation, transmission, and distribution of electric power)
5. Electronics (electronic devices and electrical circuits for producing, detecting, and controlling electrical signals for a wide variety of applications)
6. Robotics and Control Systems (machines and systems that perform/control automated processes)

Associated Professional Society: Institute of Electrical & Electronics Engineers (IEEE) (www.ieee.org)

ENGINEERING MANAGEMENT (EMgmt)

Overall Focus: Combine management courses and engineering classes to prepare graduates to work in technology-driven businesses.

Note: While a few programs exist at the undergraduate (bachelor’s degree) level, the vast majority of offered programs are at the graduate (masters degree) level, reflecting that this course of study is mainly pursued in graduate school by students with previous engineering work experience.

Associated Professional Society: American Society for Engineering Management (ASEM) (www.asem.org)

ENGINEERING MECHANICS (EMech)

Overall Focus: Research into, and application of, basic engineering mechanics principles.

Primary Areas of Specialization:

1. Mechanics of Solids (examining behavior of both bodies at rest (bridges, buildings, etc.) – “Statics” – and bodies in motion (cars, spacecraft, etc.) – “Dynamics”)
2. Mechanics of Fluids (examining behavior of both liquids and gases, with engineering applications in design of basic types of equipment – pumps, compressors, turbines, engines – and in energy production)

Associated Professional Society: American Society of Mechanical Engineers (ASME) (www.asme.org)

ENGINEERING PHYSICS & ENGINEERING SCIENCE (EPHy/ESci)

Overall Focus: Research into, and application of, principles from basic scientific fields (particularly physics) with an eye towards engineering applications.

ENVIRONMENTAL ENGINEERING (EnvE)

Note: Environmental Engineering is also a frequent area of specialization under both Chemical and Civil Engineering.

Overall Focus: Issues involving the protection and preservation of the environment, including sustainable use of the earth's natural resources.

Primary Areas of Specialization:

1. Air Pollution Control
2. Hazardous Waste Treatment and Disposal
3. Natural Systems Modeling
4. Recycling and Solid Waste Disposal
5. Sanitary Engineering (municipal and industrial water and wastewater treatment)
6. Water Resources (control and use of water, focusing on flood control, irrigation, raw water supply, and hydroelectric power applications)

Associated Professional Society: American Academy of Environmental Engineers (AAEE) (www.aeee.net)

GEOLOGICAL ENGINEERING (GeoE)

Overall Focus: Application of geological principles with a focus on the exploration for, and extraction of, natural resources (oil, natural gas, coal, minerals, etc.).

Note: Geotechnical Engineering – which applies geological principles in support of civil engineering projects, such as the construction of buildings, roads, and dams – is a separate discipline offered under Civil Engineering.

Associated Professional Society: Society for Mining, Metallurgy, and Exploration (SME) (www.smenet.org)

GEOTECHNICAL ENGINEERING

See listing under “Civil Engineering”

INDUSTRIAL ENGINEERING (IE)

Overall Focus: Efficiency, or, more precisely, how to design, organize, implement, and operate the basic factors of production (materials, equipment, people, information, and energy) in the most efficient manner possible. The typical focus is on optimizing industrial manufacturing operations, although the skills learned can be applied to other non-manufacturing settings.

Primary Areas of Specialization:

1. Ergonomics / Human Factors Engineering (designing the workplace to better accommodate “human factors” (human abilities and behaviors), thereby yielding more efficient operations and fewer accidents or injuries).
2. Facility Design (aimed at operational efficiency)
3. Management Decision Making / Operations Research (using statistics and other forms of data analysis to aid in making management decisions)
4. Manufacturing Engineering (concerned with all aspects of manufacturing operations – materials, parts, equipment, facilities, labor, finished products, delivery, etc.).
5. Quality Control (using sampling, statistical analysis and other techniques to assess and maintain the quality of products or services provided by a business or other organization)
6. Work Design (defining jobs that individual workers do in performing the overall work of the organization, with the typical focus being on optimizing manufacturing operations).
7. Worker Productivity (conducting time and motion studies, setting work performance standards, and proposing new/improved work methods)

Associated Professional Society: Institute of Industrial Engineers (IIE) (www.iienet.org)

MANUFACTURING ENGINEERING (ManE)

See “Industrial Engineering”

Associated Professional Society: Society of Manufacturing Engineers (SME) (www.sme.org)

MATERIALS ENGINEERING (MatE)

Alternative Name: Materials Science and Engineering (reflecting the heavy emphasis on studying materials science that such programs often entail)

Overall Focus: Development and application of “advanced materials” – ceramics, polymers, metallic alloys/specialty metals, electronic materials, composites, etc.

Note: While Materials Engineering is concerned with developing and applying advanced material, commercial-scale production of such materials is the realm of Chemical Engineering – see separate entry).

Primary Areas of Specialization:

1. Ceramic Materials
2. Composite Materials (combining different materials to produce an advanced material)
3. Electronic Materials (used in computers and other electronic devices)
4. Materials Science (examining the structure and properties of various materials, with particular focus on material failure issues - fracture, fatigue, corrosion, etc.)
5. Metallurgical Engineering (focusing on metallic alloys and specialty metals)
6. Polymeric Materials (plastics, synthetic rubbers and fibers, films, etc.)

Associated Professional Society: Minerals, Metals, and Materials Society (TMS) (www.tms.org)

MECHANICAL ENGINEERING (ME)

Overall Focus: Machines, structures, devices, mechanical systems, and energy conversion systems.

Note: Mechanical Engineering is often considered the broadest of engineering disciplines, with overlap into many of the other existing engineering disciplines, including Civil, Electrical, and Chemical Engineering.

Primary Areas of Specialization:

1. Solid Mechanics (analyzing the behavior of solid bodies subjected to external loads, stress, and/or vibrations and using that information in the design and manufacture/construction of such bodies)
2. Fluid Mechanics (analyzing the behavior of liquids and gases and using that knowledge in the design and development of machinery and systems that can and/or do influence that behavior – pumps, fans, turbines, piping systems, etc.)
3. Thermodynamics (analyzing the conversion one form of energy into another and using that knowledge to design and develop energy conversion devices and systems – power plants, engines, Heating, Ventilation, and Air Conditioning (HVAC) systems, etc.)
4. Mechanical Design (covering the full range of mechanical-based products and systems)

Associated Professional Society: American Society of Mechanical Engineers (ASME) (www.asme.org)

METALLURGICAL ENGINEERING (MetE)

See “Materials Engineering”

Associated Professional Society: Society for Mining, Metallurgy, and Exploration (SME) (www.smenet.org)

MINING & MINERAL ENGINEERING (MineE)

Overall Focus: Finding, extracting, and processing coal, metallic ores (such as copper, nickel, zinc, and gold) and other minerals (such as diamonds)

Primary Areas of Specialization:

1. Identification and Estimation of Mineral Reserves
2. Mine Design & Operation
3. Mining Equipment Design & Operation
4. Mineral Processing

Associated Professional Society: Society for Mining, Metallurgy, and Exploration (www.smenet.org)

NAVAL ARCHITECTURE & MARINE ENGINEERING

See Also: Ocean Engineering

Overall Focus: Design and development of ships and other water-based vessels and offshore and ocean bottom structures.

Primary Areas of Specialization:

1. Ships and Other Water-Based Vessels
2. Offshore and Ocean Bottom Structures

Associated Professional Society: Society of Naval Architects & Marine Engineers (SNAME) (www.sname.org)

NUCLEAR ENGINEERING (NucE)

Overall Focus: All engineering applications of nuclear/radioactive materials.

Primary Areas of Specialization:

1. Nuclear Power (including both nuclear power plants and nuclear-driven engines in submarines and spacecraft).
2. Nuclear Weapons Systems.
3. Radiation Sciences / Radiological Engineering (use of radioactive materials for medical or industrial applications)

Associated Professional Society: American Nuclear Society (ANS) (www.ans.org)

OCEAN ENGINEERING (OE)

See Also: Naval Architecture and Marine Engineering

Overall Focus: Operations in, around, or on the ocean.

Primary Areas of Specialization:

1. Ocean Exploration (including design of submersible vehicles)
2. Ocean Structures (offshore drilling platforms, ocean bottom structures, underwater pipelines, etc.)
3. Pollution Control (focusing on the coastline environment)
4. Wave Action Effects (on beaches, docks, harbor facilities, etc.) and Their Prevention/Mitigation

Associated Professional Society: Ocean, Offshore and Arctic Engineering (OOAE) Division of the American Society of Mechanical Engineers (www.ooae.org)

PETROLEUM ENGINEERING (PetroE)

Overall Focus: The identification, extraction, storage, and transportation of crude oil and natural gas.

Note: Processing (refining) crude oil is in realm of Chemical Engineering (see separate entry)

Primary Areas of Specialization:

1. Identification and Estimation of Crude Oil and Natural Gas Reserves
2. Land-Based Well Drilling Equipment/Facilities and Operations
3. Offshore Well Drilling Equipment/Facilities and Operations
4. Storage and Transportation Equipment/Facilities and Operations

Associated Professional Society: Society of Petroleum Engineers (SPE) (www.spe.org)

SOFTWARE ENGINEERING (SoftE)

See “Computer Engineering”

STRUCTURAL ENGINEERING (StrE)

See listing under “Civil Engineering”

SURVEYING

See listing under “Civil Engineering”

Associated Professional Society: American Congress on Surveying and Mapping (ACSM) (www.acsm.net)

SYSTEMS ENGINEERING (SysE)

Overall Focus: Ensuring the successful development and operation of large and complex engineered systems (such as transportation, communication, water/food distribution, and defense systems).

Associated Professional Society: International Council on Systems Engineering (www.incose.org)