Four main engineering descriptions

## Civil engineers

Civil engineers plan, design, build, and maintain roads, buildings, water treatment facilities, landfills, and many other structures. They also:

• provide safe drinking water, control flooding, and runoff;

• design foundations for buildings and structures;

• provide reliable and economical bridges, port facilities, and intricate dams;

• move people and cargo from place to place;

• refine construction techniques;

• manage projects, quality control, and contract administration; and

• develop construction materials such as asphalt, concrete, and composites (MUST 2018a).

Job opportunities exist in “consulting (municipal services, transportation, hazardous waste mitigation), government agencies (state departments of transportation, city planners, municipal engineers), and industry (structural engineers, construction, project managers/analysts)” (MUST 2018a).

## Mechanical engineers

Mechanical engineering involves the creation of almost anything that moves or anything manufactured, whether it be:

• products: the car you drive to school, the potato chips you eat at lunch, or the air-conditioning system that keeps you comfortable at home.

• specialize: manufacturing, controls, dynamics, instrumentation, fluid mechanics, robotics, mechanics, materials, or transportation.

• overall: Mechanical engineers are involved in making items (MUST 2018b).

## Chemical engineers

Chemical engineers consider “the fundamental properties and nature of matter, the forces that act on matter, and the precise expressions of the relationships between them” (MUST 2018c).Chemical engineers can develop specialized polymeric materials for use in artificial limbs, lightweight materials to be used in aircraft, or even new processes for the application of biochemistry, energy conservation, or environmental controls. They often work in fields such as health, food, agriculture, biotechnology, and petroleum (MUST 2018c):

* environmental: pure water obtained from the sea;
* design processes using chemistry: to make fertilizers, rubber, fibers, fuels, plastics, and other chemicals. These may be new plants. Some plants may change processes to make them safer and more efficient.
* new materials: Find supplemental food sources or develop new processes for the application of biochemistry, energy conservation, or environmental controls (MUST 2018c).

## Electrical engineers

Electrical engineers are involved in channeling natural resources into uses for society such as heating, lighting, home appliances, consumer products, computing, sensing, control, and communication. They contribute to systems and devices for power, instrumentation, measurement, communication, management, manufacturing, transportation, and so on. They are primarily concerned with the processes of generation, transmission, transformation, control, and utilization of energy or information.

Electrical engineering is a very broad profession. You might work in:

* circuits: the application of basic electrical elements—energy sources, resistors, inductors, capacitors, diodes, and transistors—as they are found interconnected in operational electrical networks.
* communications-signal processing: the makeup of information-bearing signals, modulation systems, and detection techniques.
* controls: design and application of circuits and systems used to automatically monitor and regulate devices, machines, and systems for optimal performance in a variety of operations, including flexible manufacturing.
* electromagnetics: high-frequency waves, antennas, and microwave systems of various types for propagation and transmission of electrical signals through space or conductors.
* optics and devices: light propagation, optical processing, fiber optics, opto-electronics, and solid-state devices that have application to telecommunications, computing, microscopy, lasers, sensing, and smart structures.
* power: the design and application of motors, generators, transformers, distribution systems, high-voltage design methods, and the economic transmission of energy (MUST 2018d).

## Engineering subdisciplines

## Aerospace engineering

From designing and developing some of the world's most marvelous machines, such as military fighter jets, jumbo jets, personal aircraft, and space telescopes, to aiding in the design of race cars and golf balls, aerospace engineering is a profession with out-of-this-world potential.

Aerospace engineers are employed by industry, government agencies (like NASA), in academia, as pilots, or often start their own company (MUST 2018e).

## Architectural engineering

“Architectural engineers plan, design, and supervise construction of many essential facilities and structures for residential, commercial, industrial, and institutional buildings. These building systems include electrical, communications and control, lighting, heating, ventilating, air conditioning, fire protection, plumbing, and structural systems” (MUST 2018f).

Architectural engineers have many career possibilities, from working with private construction and consulting companies, to a career in government or civil service as a building inspector, project manager, or construction specialist (MUST 2018f).

## Biomedical engineering

“Biomedical engineering lies at the intersection of the physical and life sciences, incorporating principles from physics and chemistry to understand the operation of living systems. As in other engineering fields, the approach is highly quantitative: mathematical analysis and modeling are used to capture the function of systems from subcellular to organism scales” (Harvard University 2018).

Biomedical engineers “translate abstract hypothesis and scientific knowledge into working systems (e.g., prosthetic devices, imaging systems, and biopharmaceuticals)” (Harvard University 2018).

## Ceramic engineering

**“Ceramic engineering** is the branch of materials engineering and science that involves inorganic, nonmetallic materials. ….Ceramic engineers design the materials that make it possible for other engineering disciplines to advance: glass fibers and optical devices for telecommunication networks, electronic ceramics that make cell phones possible, high- temperature materials that allow jet engines to operate at more efficient temperatures, and biocompatible materials that replace diseased tissues. Ceramic engineers use basic principles from chemistry and physics to understand how to design new materials at the atomic level, then to process these materials into useful forms” (MUST 2018g).

## Computer engineering

Computer engineers “work with software and hardware of computers. In the software world, high-level languages and complex programs are often the solution to a problem. In the hardware world, designs also include many aspects of the physical world, like temperature or noise, and often must include compromises between many opposing factors. The ability of a computer engineer to work in both worlds is what distinguishes them from a computer scientist or from an electrical engineer who specializes in computers. Computer scientists typically have little training with hardware. Electrical engineers typically have little training with software.” Computer engineers “are trained to work with both, since many computer systems cannot be built well without a clear understanding of both. Computer engineers can be found just about anywhere there are computers. Computer engineers might build the integrated circuits (ICs) that go into a home video game or cell phone. They might develop the microprocessor that goes into your home computer, deciding what instructions it executes and how it interfaces with memory. Computer engineers also build computer systems that use these integrated circuits ….” (MUST 2018h).

## Environmental engineering

“Environmental engineers uphold the dual goals of minimizing our impact on the local, regional, and global environment and concurrently improving our standard of living. In this role of preserving environmental and public well-being, environmental engineers face unique issues and must have a strong background in the Earth sciences to understand complex environmental problems and then pose and design appropriate engineering solutions. As problem solvers for something as diverse as the environment, environmental engineers also need to understand the most current technologies used in practice and have a desire to maintain a high level of learning in this rapidly evolving field.

Drinking water and wastewater treatment are cornerstones of the environmental engineering field….. Turning river, lake, or even sea water into drinking water requires a unique expertise because each water source offers distinctive challenges. Air pollution is a growing concern on scales ranging from the global atmosphere to the indoor environment” (MUST 2018i).

## Geological engineering

## “Geological engineers work on a variety of projects that involve the Earth and its resources. For example, a geological engineer may be involved in the design of a project to protect wetlands or in the cleanup of lead contaminated soil that threatens peoples' homes. Geological engineers may develop safe drinking water supplies in parts of the world where infant mortality is many times higher than it is in the United States. Geological engineers work on protecting infrastructure such as bridges, buildings, and utilities from earthquake damage. Geological engineers evaluate the use of naturally-occurring materials such as clay to prevent the spread of subsurface contamination. Geological engineers are interested in the development of renewable energy resources to conserve traditional sources of energy. Geological engineers work with the environment to improve conditions for everyone and the world around us” (MUST 2018j).

## Metallurgical engineering

## “The field of metallurgical engineering starts with the production and recycling of metals such as aluminum, steel, copper, magnesium, and titanium. Once these metals are made, metallurgical engineers design forming and processing techniques to transform these metals into useful shapes with the properties required for their application” (MUST 2018k).

## “Metallurgical engineers control the properties of metallic materials by altering the microscopic structure with alloying additions and special treatments. This approach leads to products such as corrosion-resistant stainless steels, ultra-lightweight alloys for aircraft, wear-resistant alloys for engines, and shape-memory alloys for space structures. In addition, investigating material failures and monitoring service life are tasks that are performed by metallurgists” (MUST 2018k).

## Mining engineering

“The mining engineering profession deals with location, extraction, and use of mineral resources and mineral policy. Lunar and ocean mining constitute new frontiers. The mining engineer is concerned with all phases of mineral recovery, including exploration, evaluation, development, extraction, mine evaluation, reclamation, processing, and marketing of minerals” (MUST 2018l). “The mining engineer relies upon geologic knowledge and highly sensitive instruments for the location and evaluation of mineral deposits” (MUST 2018l).

## Nuclear engineering

## “Nuclear engineers develop and promote the utilization of energy released from nuclear fission, fusion, and the decay of radioisotopes. Currently, there are more than 100 nuclear power plants operating in the United States, producing about 20% of our nation's electricity. These plants use nuclear fission to produce energy and are cooled by ordinary (light) water, hence the name, light water reactors. This technology reduces the emission of greenhouse gases such as carbon dioxide significantly, thus contributing to a better environment. In addition, nuclear reactors are used for the propulsion of submarines and aircraft carriers” (MUST 2018m).

“Radioisotopes are used in industry and research, and in medicine for diagnostic and therapeutic purposes. The medical use of radioisotopes and X-rays saves hundreds of thousands of lives every year throughout the world. Radioisotopes are also used in small power generators for space flights” (MUST 2018m).

## Petroleum engineering

Petroleum engineers seek out oil and gas reservoirs beneath the Earth's surface. They develop the safest and most efficient methods of bringing those resources to the surface and to market. Many petroleum engineers travel the world or live in foreign countries— wherever their explorations take them to find and recover valuable petroleum reserves. These travels can lead to the deserts, high seas, mountains, and arctic regions of the world in order to find untapped sources of energy for the world's population. Petroleum engineers also tend to quickly assume leadership roles, handling large projects with high levels of responsibility (MUST 2018n).

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