CAREER RESOURCES

Engineering Disciplines Defined

Are you comfortable working with mechanical engineers but not as well-versed working with chemical engineers? Use the following information and become educated at a high level, as you learn more about other engineering skill sets.

Aeronautical and Aerospace Engineering

Aeronautics deals with the whole field of design, manufacture, maintenance, testing, and use of aircraft for both civilian and military purposes. It involves the knowledge of aerodynamics, structural design, propulsion engines, navigation, communication, and other related areas.

Aerospace engineering is closely allied to aeronautics, but is concerned with the flight of vehicles in space, beyond the earth's atmosphere, and includes the study and development of rocket engines, artificial satellites, and spacecraft for the exploration of outer space.

Chemical Engineering

This branch of engineering is concerned with the design, construction, and management of factories in which the essential processes consist of chemical reactions. Because of the diversity of the materials dealt with, the practice, for more than 50 years, has been to analyze chemical engineering problems in terms of fundamental unit operations or unit processes such as the grinding or pulverizing of solids. It is the task of the chemical engineer to select and specify the design that will best meet the particular requirements of production and the most appropriate equipment for the new applications.

With the advance of technology, the number of unit operations increases, but of continuing importance are distillation, crystallization, dissolution, filtration, and extraction. In each unit operation, engineers are concerned with four fundamentals: (1) the conservation of matter; (2) the conservation of energy; (3) the principles of chemical equilibrium; (4) the principles of chemical reactivity. In addition, chemical engineers must organize the unit operations in their correct sequence, and they must consider the economic cost of the overall process. Because a continuous, or assembly-line, operation is more economical than a batch process, and is frequently amenable to automatic control, chemical engineers were among the first to incorporate automatic controls into their designs.

Civil Engineering

Civil engineering is perhaps the broadest of the engineering fields, for it deals with the creation, improvement, and protection of the communal environment, providing facilities for living, industry and transportation, including large buildings, roads, bridges, canals, railroad lines, airports, water-supply systems, dams, irrigation, harbors, docks, aqueducts, tunnels, and other engineered constructions.

The civil engineer must have a thorough knowledge of all types of surveying, of the properties and mechanics of construction materials, the mechanics of structures and soils, and of hydraulics and fluid mechanics. Among the important subdivisions of the field are construction engineering, irrigation engineering, transportation engineering, soils and foundation engineering, geodetic engineering, hydraulic engineering, and coastal and ocean engineering.

Electrical and Electronics Engineering

The largest and most diverse field of engineering, it is concerned with the development and design, application, and manufacture of systems and devices that use electric power and signals. Among the most important subjects in the field in the late 1980s are electric power and machinery, electronic circuits, control systems, computer design, superconductors, solid-state electronics, medical imaging systems, robotics, lasers, radar, consumer electronics, and fiber optics.

Despite its diversity, electrical engineering can be divided into four main branches: electric power and machinery, electronics, communications and control, and computers.

Electric Power and Machinery

The field of electric power is concerned with the design and operation of systems for generating, transmitting, and distributing electric power. Engineers in this field have brought about several important developments since the late 1970s. One of these is the ability to transmit power at extremely high voltages in both the direct current (DC) and alternating current (AC) modes, reducing power losses proportionately. Another is the real-time control of power generation, transmission, and distribution, using computers to analyze the data fed back from the power system to a central station and thereby optimizing the efficiency of the system while it is in operation.

Computers

Virtually unknown just a few decades ago, computer engineering is now among the most rapidly growing fields. The electronics of computers involve engineers in design and manufacture of memory systems, of central processing units, and of peripheral devices. Foremost among the avenues now being pursued are the design of Very Large Scale Integration (VLSI) and new computer architectures. The field of computer science is closely related to computer engineering; however, the task of making computers more “intelligent” (artificial intelligence,), through creation of sophisticated programs or development of higher level machine languages or other means, is generally regarded as being in the realm of computer science.

One current trend in computer engineering is microminiaturization. Using VLSI, engineers continue to work to squeeze greater and greater numbers of circuit elements onto smaller and smaller chips. Another trend is toward increasing the speed of computer operations through use of parallel processors, superconducting materials, and the like.

Geological and Mining Engineering

This branch of engineering includes activities related to the discovery and exploration of mineral deposits and the financing, construction, development, operation, recovery, processing, purification, and marketing of crude minerals and mineral products. The mining engineer is trained in historical geology, mineralogy, paleontology, and geophysics, and employs such tools as the seismograph and the magnetometer for the location of ore or petroleum deposits beneath the surface of the earth.

The surveying and drawing of geological maps and sections is an important part of the work of the engineering geologist, who is also responsible for determining whether the geological structure of a given location is suitable for the building of such large structures as dams.

Industrial or Management Engineering

This field pertains to the efficient use of machinery, labor, and raw materials in industrial production. It is particularly important from the viewpoint of costs and economics of production, safety of human operators, and the most advantageous deployment of automatic machinery.

Mechanical Engineering

Engineers in this field design, test, build, and operate machinery of all types; they also work on a variety of manufactured goods and certain kinds of structures. The field is divided into (1) machinery, mechanisms, materials, hydraulics, and pneumatics; and (2) heat as applied to engines, work and energy, heating, ventilating, and air conditioning. The mechanical engineer, therefore, must be trained in mechanics, hydraulics, and thermodynamics and must be fully grounded in such subjects as metallurgy and machine design. Some mechanical engineers specialize in particular types of machines such as pumps or steam turbines.

A mechanical engineer designs not only the machines that make products but the products themselves, and must design for both economy and efficiency. A typical example of the complexity of modern mechanical engineering is the design of an automobile, which entails not only the design of the engine that drives the car but also all its attendant accessories such as the steering and braking systems, the lighting system, the gearing by which the engine's power is delivered to the wheels, the controls, and the body, including such details as the door latches and the type of seat upholstery.

Military Engineering

This branch is concerned with the application of the engineering sciences to military purposes. It is generally divided into permanent land defense and field engineering. In war, army engineer battalions have been used to construct ports, harbors, depots, and airfields. In the U.S., military engineers also construct some public works, national monuments, and dams.

Military engineering has become an increasingly specialized science, resulting in separate engineering subdisciplines such as ordnance, which applies mechanical engineering to the development of guns and chemical engineering to the development of propellants, and the Signal Corps, which applies electrical engineering to all problems of telegraph, telephone, radio, and other communication.

Naval or Marine Engineering

Engineers who have the overall responsibility for designing and supervising construction of ships are called naval architects. The ships they design range in size from ocean-going supertankers as much as 1,300 feet long to small tugboats that operate in rivers and bays. Regardless of size, ships must be designed and built so that they are safe, stable, strong, and fast enough to perform the type of work intended for them. To accomplish this, a naval architect must be familiar with the variety of techniques of modern shipbuilding, and must have a thorough grounding in applied sciences, such as fluid mechanics, that bear directly on how ships move through water.

Marine engineering is a specialized branch of mechanical engineering devoted to the design and operation of systems, both mechanical and electrical, needed to propel a ship. In helping the naval architect design ships, the marine engineer must choose a propulsion unit, such as a diesel engine or geared steam turbine, that provides enough power to move the ship at the speed required. In doing so, the engineer must take into consideration how much the engine and fuel bunkers will weigh and how much space they will occupy, as well as the projected costs of fuel and maintenance.

Nuclear Engineering

This branch of engineering is concerned with the design and construction of nuclear reactors and devices, and the manner in which nuclear fission may find practical applications, such as the production of commercial power from the energy generated by nuclear reactions and the use of nuclear reactors for propulsion and of nuclear radiation to induce chemical and biological changes. In addition to designing nuclear reactors to yield specified amounts of power, nuclear engineers develop the special materials necessary to withstand the high temperatures and concentrated bombardment of nuclear particles that accompany nuclear fission and fusion. Nuclear engineers also develop methods to shield people from the harmful radiation produced by nuclear reactions and to ensure safe storage and disposal of fissionable materials.

Safety Engineering

This field of engineering has as its object the prevention of accidents. In recent years safety engineering has become a specialty adopted by individuals trained in other branches of engineering. Safety engineers develop methods and procedures to safeguard workers in hazardous occupations. They also assist in designing machinery, factories, ships, and roads, suggesting alterations and improvements to reduce the likelihood of accident. In the design of machinery, for example, the safety engineer seeks to cover all moving parts or keep them from accidental contact with the operator, to put cutoff switches within reach of the operator, and to eliminate dangerous projecting parts. In designing roads the safety engineer seeks to avoid such hazards as sharp turns and blind intersections, known to result in traffic accidents. Many large industrial and construction firms, and insurance companies engaged in the field of workers compensation, today maintain safety engineering departments.