

Electrical Engineers



Occupational Brief Title Codes:

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Occupational Subtitles:

- Electrical Engineering Technicians

Work Classification Based Related

D.O.T. Occupations:

- Computer-Aided Design Technicians
- Controls Designers
- Electrolysis-and-Corrosion-Control Engineers
- Illuminating Engineers
- Power-Distribution Engineers

Interests Based Related

G.O.E. Occupations:

- Applications Engineers
- Electronics Engineers
- Electronics Engineering Technicians
- Illuminating Engineers
- Power-Distribution Engineers

Skills Based Related

O*NET Occupations:

- Aerospace Engineers
- Calibration and Instrumentation Technicians
- Electrical and Electronics Repairers, Commercial and Industrial Equipment
- Electricians
- Engineering Managers

Noteworthy Quote:

"Many of the items we use in our daily lives were made possible by the efforts of an earlier generation of electrical engineers and technicians. Students entering this field have the opportunity to use their education and talents to continue this trend through the new millennium."

— **Kurt Schuler, General Manager, American Society of Certified Engineering Technicians, Flowery Branch, Georgia**

Electrical engineers (e`lec-tri-cal en-gi`neers) design, develop, and test equipment that uses electricity as a source of energy.

Electricity supplies light, power to run appliances and machinery, and communications such as the telephone, radio, and television. People take for granted the clock radio that wakes them to music, the coffee maker that brews perfect coffee, and the telephone they can pick up to call anyone. Color televisions, microwave ovens, and home computers are commonplace. But it is the ingenuity and skill of electrical engineers that make these devices possible.

Work Performed

Electrical engineers design, develop, test, and supervise the manufacture of electrical equipment. This equipment includes power generating, controlling, and transmission devices used by electric utilities; electric motors, machinery controls, lighting, and wiring in buildings, automobiles, aircraft, and ships; and equipment used in radar and navigation systems, computer and office equipment, and broadcast and communications systems.

Electrical engineers are often known by the kind of work they do. They may work in research, development, design, production, testing, sales, applications, or construction. Others work in analysis, management, consulting, teaching, and journalism.

Electrical engineers in research and development departments study basic sciences. They envision and design new technologies. They study processes and products to make working models of their ideas, called prototypes. They use their findings to create original products or processes, or to improve performance or usability of existing products or processes.

Electrical engineers in marketing and sales convince the public or manufacturers of the need for the products. They also instruct customers on the use of leased or purchased equipment. Some engineers construct and install industrial tools and equipment for customers. Others work in the field adjusting, repairing, or replacing defective equipment.

Engineers who work in management direct workers and other engineers. Those in consulting give their clients advice on the designs, plans, supervision, and construction of projects. They sometimes serve as consultants to government and industry.

In whatever specialty they work, electrical engineers design new products, write performance requirements, and develop maintenance schedules. They also design test equipment, solve operating problems, and estimate the time and costs to complete engineering projects.

Because their work is so far-reaching and so comprehensive, engineers often work with professionals in other fields. They may work with architects, highway engineers, physicians, or members of many other professions.

Electrical engineering technicians work with and support electrical engineers. They gather data, carry out tests, prepare estimates, conduct inspections, write technical reports, and draft designs. This gives engineers extra time so that they can work on research and development.

Technicians may help electrical engineers design equipment ranging from huge generators that produce electric power for factories to devices that deliver heat or light. They may draw layouts of electrical circuits, assemble prototypes, test units such as motors or regulators, or test components such as solenoids or circuit breakers.

Technicians may test and install computers; telephone systems; medical, dental, and industrial equipment; welding gear; and ultrasonic devices. They may gather data that the engineers use to check compliance with specifications. They may repair and do preventive maintenance on these products.

Technicians in drafting and design work use drafting instruments, computer-aided design and drafting programs, and calculators. Other technicians may use test equipment and hand tools such as soldering irons, pliers, and wire strippers.

Working Conditions

Most electrical engineers and technicians work in industrial plants. They may work in environmentally controlled laboratories, in production departments, or in offices. Engineers and technicians often work with others. Some, however, work either alone or with one or two other persons on small-scale projects. Some electrical engineers may travel now and then to places such as construction sites or manufacturing facilities to check the installation of equipment, or to deal with on-site problems.

Hours and Earnings

Many engineers and technicians work a standard forty-hour week. However, time deadlines or design standards may bring extra pressure and extra hours to the job.

Earnings for electrical engineers and technicians vary with their responsibilities, experience, education, and skill. Earnings also vary by industry, employer, and geographic location.

According to the Bureau of Labor Statistics, in 2002, the average salary for electrical engineers was \$70,480 a year. Overall, most earnings ranged anywhere from a low of \$44,780 a year to a high of \$100,980 a year. A 2003 salary survey by the National Association of Colleges and Employers reported starting offers for bachelor's degree candidates in electrical/electronics and communications engineering averaged \$49,794 a year. Master's degree candidates averaged \$65,556 a year, and Ph.D. candidates averaged \$74,283 a year.

In 2002, the average earnings of electrical and electronic engineering technicians was \$44,210 a year according to the Bureau of Labor Statistics. Overall, most earnings ranged from a low of \$26,770 a year to a high of \$64,070 a year. In industries employing the greatest number of technicians, earnings were highest in federal government

which averaged around \$58,000 a year, followed by wired telecommunications which averaged around \$49,000 a year.

Most electrical industries offer excellent fringe benefits. Workers get pension and retirement plans, life and hospital insurance, and paid sick leave. Most workers receive two weeks of paid vacation and six to eight paid holidays a year. To encourage workers to keep on with their schooling, many firms pay for all or part of the tuition, and grant time off for classes.

Education and Training

Electrical engineers must have at least a four-year bachelor's degree in electrical engineering from an engineering program accredited by the Accreditation Board for Engineering and Technology (ABET). Further study may be required for specialties. Some studies are available only in graduate school, and some employers prefer engineers with a master's or a doctoral degree.

Electrical engineering technicians should complete a two-year or a three-year associate degree program in engineering technology. Training is offered through technical institutes, community colleges, extension divisions of four-year colleges and universities, public and private vocational-technical schools, and in the Armed Forces. Studies are similar to those of electrical engineers, but the emphasis is on practical knowledge rather than theory. Because programs vary in type and quality of training, employers generally prefer graduates of ABET-accredited programs.

Most undergraduate electrical engineering and technology school programs require a solid background in mathematics and science. Engineers and technicians must also have a working knowledge of English in order to read, speak, and write well. High school students should take courses in English, algebra, plane and solid geometry, trigonometry, general science, physics, and chemistry. Course work in mechanical drawing, computer-aided design, and computer and information technology will also prove useful.

About 340 colleges and universities offer accredited bachelor's degree programs in engineering. Bachelor's degree programs in engineering typically are designed to last four years. Typically, the first two years are spent studying mathematics, basic sciences, introductory engineering, humanities, and social sciences. In the last two years, most courses are in engineering, usually with a concentration in one branch. Some programs, however, offer a general engineering curriculum.

Some engineering schools have an arrangement with two-year or liberal arts colleges. The students complete the first two or three years at the two-year or liberal arts school, and the engineering school automatically admits students for their last two years. Some colleges and

universities offer five-year master's degree programs. Many colleges also offer cooperative education programs. In these programs students alternate class study with related industrial work. These students not only earn money to help meet their school costs but also get experience.

Around 240 colleges offer accredited bachelor's degree programs in engineering technology. Graduates of four-year technology programs may get jobs similar to those obtained by graduates with a bachelor's degree in engineering. However, some employers regard technology program graduates as having skills between those of a technician and an engineer.

Accredited two-year associate degree programs in engineering technology prepare students to become technicians. These programs may lead to an associate degree in science, an associate degree in engineering technology, or an associate degree in applied science. In the first year they take mathematics, science, electricity, social science, and English. Second-year students attend lectures and laboratory sessions to learn the principles and theory of electricity, and how they apply to circuits, power systems, and controls. Other subjects include microprocessors and digital electronics.

Continuing education is crucial for electrical engineers and technicians. Those who fail to keep up with rapid changes in technology risk becoming more susceptible to layoffs, and are more likely to be passed over for advancement.

Licensing and Certification

All fifty states and the District of Columbia require the licensure and registration of all engineers whose work may affect the life, health, or property of the public. Engineers who are licensed are called Professional Engineers (PE). To get this standing, engineers must earn at least a four-year engineering degree from an accredited program, have four years of appropriate experience, and successfully complete a state examination. Most applicants take the first part of the exam on graduation. After acquiring suitable work experience, they can then take the second part of the exam. Many states have also imposed mandatory continuing education requirements to maintain licensure. Few states accept applicants with a degree in engineering technology.

Although employers usually do not require engineering technicians and technologists to be certified, certification can provide a competitive advantage. The National Institute for Certification in Engineering Technologies (NICET) offers voluntary certification for engineering technicians and technologists. Certification is available at various levels in 1 of about 30 specialties. To qualify, applicants must meet a certain amount of job-related experience, submit a supervisory evaluation and a recommendation, and pass a written examination.

Personal Qualifications

Engineers must have good reasoning skills. They must be creative, inquisitive, analytical, and detail-oriented. They should have energy, drive, and patience. They must be flexible and able to work as part of a team. Strong communication skills are important because engineers often interact with others, including specialists in a wide range of fields outside engineering.

Technicians should enjoy work that requires both action and thought. The ability to use symbols to describe processes, and an understanding of the concept of scale in constructing models are important. Like engineers, technicians must be able to work well with others because they are often part of a team of engineers and other technicians. They should also have good communication skills.

Occupations can be adapted for workers with disabilities. Persons should contact their school or employment counselors, their state office of vocational rehabilitation, or their state department of labor to explore fully their individual needs and requirements as well as the requirements of the occupation.

Where Employed

Electrical engineers held around 146,000 jobs throughout the United States in 2002. Separate figures for electrical engineering technicians were not available, however, electrical and electronic engineering technicians combined held roughly 204,000 jobs.

Electrical engineers and technicians work in factories that make electrical equipment, business and industrial machines, professional and scientific equipment, and aircraft and marine parts. Other major employers include communications services, utilities firms, government agencies, wholesale trade, and professional, scientific, and technical services firms.

Employment Outlook

Opportunities for electrical engineering and technology graduates should be favorable. The number of job openings resulting from employment growth, as well as the need to replace electrical engineers and technicians who transfer to other occupations or leave the labor force, is expected to be in rough balance with the supply of graduates.

Projected job growth stems largely from rising demand for electrical and electronic goods, including advanced communications equipment, defense-related electronic equipment, and consumer electronics products. The need for electronics manufacturers to invest heavily in research and development to remain competitive and have a scientific edge will provide openings for graduates who have learned the latest technologies.

Foreign competition for electronic products and increasing use of engineering services performed in other countries, however, will act to limit employment growth of

electrical engineers. The growing use of advanced technologies, such as computer simulation and computer-aided design and drafting will continue to increase productivity and limit job growth for technicians. As a result, job growth is expected to be fastest in engineering consulting services industries.

Entry Methods

Graduates of engineering schools and electrical technology programs often find jobs through their schools' career services offices. Some engineering corporations send recruiters to college campuses to interview seniors or graduate students.

Job seekers should always have a current resume listing their background, education, and experience. Graduates may apply to companies or to government agencies. Engineering societies, employment offices, and want ads in newspapers may offer leads to employment.

Advancement

Engineers begin work under the direction of experienced engineers who teach them company policies and processes. Company programs may lead beginners to specialties and will increase their chances of promotion. As they acquire skills and knowledge they advance to more responsible work with greater independence to develop designs, solve problems, and make decisions.

Engineers may also become technical specialists or supervise a staff or team of engineers and technicians. Some may eventually move into management posts or related sales jobs. To improve their chances of advancement, some engineers earn a graduate degree in business administration or law.

Technicians begin work under the direction of experienced technicians or engineers. In time they take on more responsible work with less supervision. They may rise to supervisory work in which they direct other technicians and production workers.

For Further Research

Accreditation Board for Engineering and Technology, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012. Web site: www.abet.org

Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08855-1331. Web site: www.ieee.org

Junior Engineering Technical Society (JETS), 1420 King Street, Suite 405, Alexandria, VA 22314-2794. Web site: www.jets.org

National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, VA 22314-2794. Web site: www.nicet.org

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