SUMMER INSTITUTE FOR ENGINEERING AND TECHNOLOGY EDUCATION

ELECTRICAL ENGINEERING

INTRODUCTION TO ELECTRICAL ENGINEERING

CONCEPT

This module explains some of the details about the work in which various Electrical Engineering specialties engage.

OBJECTIVES

1. To expose the readers to the type of work Electrical Engineers do.
2. To give the readers an idea about the courses the students would require to take to pursue a degree in Electrical Engineering.
3. To explain about the career opportunities for Electrical Engineers.

SCIENCE PROCESS SKILLS

- Informing
- Inquiring
- Exploring

AAAS SCIENCE BENCHMARKS:

- 1B Scientific Inquiry
- 3C Issues of Technology
- 12D Communication Skills

SCIENCE EDUCATION CONTENT STANDARDS (NRC)

Grades 5-8:

- Communications

Grades 9-12:

- Technology
- Identify disciplines in Electrical Engineering

STATE SCIENCE CURRICULUM FRAMEWORKS:

Grades 5-8: 1.1.9, 1.1.19, 2.1.8, 2.1.11

Grades 9-12: 1.1.19

INTRODUCTION

Electrical Engineering implies electricity, which has flowed into every aspect of our lives. Electricity supplies power to run appliances, heavy machinery, and lights. Electricity also encompasses communications such as the telephone, radio, and television and other consumer electronic devices. And, of course, electronics is changing everything around us every day, through such pervasive devices as hand-held calculators, computers, and controllers that help operate automobiles, airplanes, and homes. Electrical Engineering is the largest engineering profession.

HISTORY

William Gilbert, an english scientist, characterized magnetism and static electricity around the year 1600, and Alexander Volta discovered that an electric current could be made to flow in 1800. In the mid-1800s, a variety of European scientists had established the general rules governing electricity, and, ultimately, theories involving electricity and magnetism were joined under a concept called electromagnetism (James Clerk Maxwell's discovery). Thomas Edison developed many useful items such as the light bulb.

THE JOB

Electrical Engineers are involved in a broad array of manufacturing systems, machines, communications networks, and transportation vehicles. It is hard to think of a machine or appliance without a microchip in it somewhere. The oldest version of electrical engineering, the generation of power, is still a large field, but its size is dwarfed by the other specialties involving electronics.

Listed below are the various fields of Electrical Engineering:

- **Circuits and Devices**: This includes microchips, the larger circuits that microchips are wired into, lasers and electrooptics, and related solid-state devices.
- **Industrial Applications**: This covers the manufacturing applications of electronics, such as insulation devices, instrumentation and measurement, and electronic devices that control power.
- **Communications Technology**: The fields included here are those most familiar to the general consumer: broadcast electronics, consumer electronics (radios, TV), communication devices (telephones, radio), and similar devices in automobiles.
- **Electromagnetics and Radiation**: This represents the more advanced realms of communications, such as those used for detecting aircraft. Subgroups include antennas and signal propagation, magnetics, microwaves, and nuclear and plasma sciences.
- **Computers**: This area includes computer-hardware and data storage, networks, and electronics for everything from hand-held calculators to supercomputers.
- **Engineering and the Human Environment**: This discipline includes engineering management, education, professional communication, and the social implications of technology.

- **Power Engineering**: These are the engineers at utility stations and those who design, construct, and maintain the generators and transmission systems.
- **Signals and Applications**: More types of advanced electronic transmission and detection are covered here, including acoustics, speech and signal processing, remote sensing, ultrasonics, and aerospace systems.
- **Systems and Control**: Electronics are capable of controlling electrical and mechanical devices, even as electricity provides the power. Robotics, industrial automation systems, information theory, and engineering medicine are some of the subgroups of this division.

Some of the typical **job titles** are:

Circuit designer : Whether it is a microcircuit etched on a silicon chip, or a circuit board on a piece of green plastic, these designers apply engineering principles to building circuits that will accomplish the desired objective. Circuit design is one of the most active areas for automated computer design.

Communications engineer : Most of the mass-market, long-distance communication networks such as telephones, radio, television, and cable television rely on these engineers to develop the best ways to send and receive the communications signal. Signal fidelity and immunity to electronic "noise" are constant goals.

Control engineer : The ability of computers and electronic devices to provide automatic control of appliances, machines, and manufacturing processes is generating high job demand for these specialists. One of the most dramatic possibilities is the use of artificial-intelligence computer programming to make processes "think".

Robotics engineer : Robotics suffered a downturn in business growth during the 1980s from which it is still recovering. But the long-term future is still bright. Robotics and control engineers share many of the same goals.

Power systems engineer : The design and operation of modern utility plants is extremely complex, more so when nuclear energy is involved. A widening gap between the capacity of newly built power plants and the demand for electricity is expected to generate high job growth for power engineers during the 1990s.

EDUCATION

Electrical/Electronics engineering requires the most mathematical knowledge of the engineering disciplnes. Whereas most other engineers are limited by the materials they use (concrete for bridges, steel for boilers), electrical/electronics engineers can work with circuits made of a great variety of materials, which can achieve a wide range of effects. Students of this field are not required to take more math courses than most other engineers, but many of them do in order to improve their proficiency.

The typical courses for an undergraduate, beyond the normal requirements for all engineering students, follow two tracks: one for electrical and computer engineering and one for computer science/computer engineering. Course topics for electrical/computer engineers include:

- electromagnetic fields

- circuit design
- logic circuits
- computer architecture
- energy conversion

For the computer science/computer engineering major, the courses include more computer programming:

- computer hardware
- software engineering
- operating systems
- communications

A wide variety of technical electives exist in the many specialty areas of electrical/electronics engineering.

CAREER OPTIONS

Electrical Engineers have a wide range of career options to choose from. The electrical engineering provides entry into nearly every type of manufacturing business, government, research, or other types of organizations.

SALARIES AND THE INTANGIBLE REWARDS

Here's the good news: at least initially, electrical engineering graduates earn the highest pay of any college graduates. Over the long term, however, salaries tend to flatten out at a level that is still very high relative to all professionals, but not the highest.

BIBLIOGRAPHY

1. Opportunities in Engineering Careers by Nicholas Basta; published by VGM Career Horizons (VGM opportunities series).
2. Introductory Experiments in Digital Electronics by Peter R. Rony, David G. Larsen, and Jonathan A. Titus; published by Howard W. Sams & Co., Inc.
3. Experimentation with Digital Electronics by John A. Dempsey; published by Addison-Wesley Publishing Co.
4. Energy, Electricity and Electronics - Applied Activities by Rex Miller and Fred W. Culpepper, Jr.; published by Mcknight & Mcknight publishing company.
5. Electrical Projects for the School and Home Workshop by Walter B. Ford; published by The Bruce Publishing company.
6. Basic Electricity/Electronics - Motors & Generators - How they work by Training & Retraining, Inc.; published by Howard W. Sams & Co., Inc.
7. Industrial Electronics - Devices, Circuits and Applications by Edward F. Driscoll; published by American Technical Society.

OTHER RESOURCES

Possible Field Trips:

- Trip to a printed circuit board manufacturing plant.
- Visit an electronics assembly plant.
- Visit to a power plant.
- Visit to a Southwestern Bell exchange switch office.
- Visit radar installation.

Addresses Of EE Organizations

The Institute of Electrical and Electronics Engineers, Inc., IEEE Service Center, 445 Hoes Lane, Piscataway, New Jersey, 08855-1331.

American Society for Engineering Education, 1818 N Street, N.W., Suite 600, Washington D.C., 20036-2479.