Electrical Engineering – what is it?

Electrical engineering is the profession concerned with systems that produce, transmit, and measure electric signals.

Over the past century and a half, electrical engineers have played a dominant role in the development of systems that have changed the way people live and work.

Satellite communication links, telephones, digital computers, televisions, diagnostic and surgical medical equipment, assembly-line robots, and electrical power tools define a modern technological society.

Electrical systems pervade our lives; they are found in homes, schools, workplaces, and transportation vehicles - everywhere.
National Academy of Engineering:
GRAND CHALLENGES FOR ENGINEERING

- A diverse committee of experts from around the world
- The most accomplished engineers and scientists of their generation
- Proposed 14 GRAND challenges
- Committee Chair, WILLIAM PERRY, Former Secretary of Defense, U.S. Department of Defense
  Professor of Engineering, Stanford University
National Academy of Engineering:
GRAND CHALLENGES FOR ENGINEERING

- Make solar energy economical
- Provide energy from fusion
- Develop carbon sequestration methods
- Manage the nitrogen cycle
- Provide access to clean water
- Restore and improve urban infrastructure
- Advance health informatics

- Engineer better medicines
- Reverse-engineer the brain
- Prevent nuclear terror
- Secure cyberspace
- Enhance virtual reality
- Advance personalized learning
- Engineer the tools of scientific discovery
Communication systems: televisions, cameras, transmitters, receivers, and VCRs; radio telescopes, used to explore the universe; network and satellite systems, radar systems, telephone systems...
Communications: 100 years ago

On January 27, 2006, Western Union sent its final telegram.

Telegraph operator printing telegram, 1908, courtesy Library of Congress
Communications: 100 years ago
Communications today: Mobile Satellite Services

Terrestrial Satellite Phone has satellite, quad-band GSM, tri-band WCDMA/HSPA connectivity along with Bluetooth and WiFi.

Convergence of Terrestrial and Satellite mobile communication systems
Communications today: GPS

The GPS system combined with computer electronics and software also forms a Signal Processing System.
Control systems: use electric signals to regulate processes.

Examples: Temperature, pressure, flow rates regulators; fuel-air mixture control in a fuel-injected automobile engine.

Motors, doors, elevators controls

Locks in the Panama Canal.

The autopilot and autolanding systems.
Control system example: dark activated switch

Actual system

Model (electric circuit)
Signal-processing systems:
transform the signals and the information contained
in them into a suitable form.

Computerized tomography
takes signals generated by an X-
ray machine and transforms them into an image.

Original X-ray signals are of little use to a physician;
once they are **processed into a recognizable image** the information they contain can be used in the diagnosis of disease or injury.
Modern electronic systems are highly sophisticated; they combine control, signal processing, communication, power and computer systems.

A sophisticated communications system enables the pilot and the air traffic controller to monitor the plane’s location.

Onboard computer system manages engine functions, implements the navigation and flight control systems, and generates video information on screens in the cockpit.

A complex control system uses cockpit commands to adjust the position and speed of the airplane.

Power system provide and distribute the electric power needed for computers, to control the engines, keep the cabin lights on, A/C, show the movie etc.

Signal-processing systems reduce the noise in air traffic communications and transform information about the plane’s location into the image on display.
Electrical Science for Engineers
ELCT 102 syllabus

I. Fundamentals of electricity

1. Electrical charges and electrical forces
2. Free electrons, conductors and insulators
3. Electrical current and voltage
4. Ohm’s law, Resistance and resistivity
5. Kirchhoff Voltage and Current conservation laws (KCL and KVL)
6. Electrical power and energy

II. Electrical network components

7. Batteries and power sources.
8. Resistors, capacitors and inductors.
9. Semiconductor materials
10. Diodes and transistors
11. Principles of micro-fabrication and microelectronics
ELCT 102 objectives

1. Students will demonstrate the understanding of and the ability to solve problems on the electric charge interactions, electric field and voltage.

2. Students will demonstrate the ability to evaluate the parameters of basic electronic components (wires, resistors, capacitors, diodes etc.) based on their physical parameters and dimensions.

3. Students will be able to solve problems on basic DC networks using Ohm’s law.

4. Students will demonstrate the ability to analyze DC circuits using Kirchhoff’s current and voltage laws.

5. Students will be able to solve problems on power dissipation in basic DC networks.

6. Students will demonstrate the ability to evaluate basic parameters of capacitors and inductors and of the series and parallel connections of those.

7. Students will be able to analyze and evaluate the characteristics of semiconductor resistors, diodes and transistors.

8. Students will demonstrate the ability to use computer tools (EXCEL, MATLAB) to solving basic DC networks and simulating the current - voltage characteristics of diodes and transistors.
ELCT 102
Electrical Science
Instructor Dr. Grigory Simin
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