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# A Career in Electronics Engineering

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# Outline

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1. The Field of EE.
2. Basic subjects.
3. Design Engineering.
4. Project-based learning.
5. Breakthrough.
6. Research.
7. Back to school.
8. Concluding remarks.

# The Field of EE

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- Roots: Power systems and communications systems.
- Growth: automatic control, signal processing, semiconductor physics, electronic circuit synthesis, optics, computer science, artificial intelligence, machine learning, . . .
- Employed in: aerospace, communications, computer, power distribution, consumer electronics, biomedical engineering and military industries.
- Graduate studies for advanced degrees in electrical engineering or related fields.
- Other application areas: business, law and medicine.

# Pioneer Electrical Engineers

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**Silvanus Phillips Thompson** Educator, author, electrical machinery, X-ray technology, radio.

**Jean Baptiste Joseph Fourier** Physicist; Fourier transform / Fourier series.

**Oliver Heaviside** Laplace transform (Operational calculus), reformulated Maxwell's equations (vector calculus).

**Paul Adrien Maurice Dirac** Dirac delta function, contributions to quantum electrodynamics.

**Thomas Alva Edison** Prolific inventor: phonograph, first practical light bulb, telegraph improvements.

**Harold Stephen Black** Negative feedback amplifier

# Basic subjects

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- Mathematics: Linear Algebra, Calculus, Advanced (Special) Calculus
- Physics, Chemistry and, recently and at special locations, Biology
- Programming, Computer Languages, Algorithms
- Numerical analysis
- Probability and Statistics
- Circuit Theory and Techniques
- Analog and Digital Electronics
- Electromagnetics
- Signals and Systems

# Research, development and design projects

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- Bachelor dissertation.
- Undergraduate Research Opportunities Program.
- Internships.
- Course projects.

# Project-based learning

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- Complement to paper-based lectures.
- Second year practicums at University of São Paulo:
  - First-semester practicum: active learning of basic circuit theory, circuit techniques, electrical instrumentation;
  - Second-semester practicum: design projects on selected or individual themes and lectures by experts.

# Breakthrough

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- “Invention has its own algorithm: genius, obsession, serendipity, and epiphany in some unknowable combination. How can you put that in a bottle?”  
(Malcolm Gladwell, The New Yorker, May 12, 2008)
- Radical invention.
- Incremental invention.
- Disruptive innovation.
- Sustaining innovation.



# Examples of disruptive innovations

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- Lower-priced Ford Model T automobile in 1908.
- Transistor radio vs. Tube radio.
- Pocket calculator vs. Desktop calculator.
- LCD TV vs. CRT TV.
- Minimills vs. Integrated steel mills.
- Mobile phones vs. Regular phones (arguably a radical invention).

# Research

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- Planning, proposals.
- Design of experiments.
- Experimentation.
- Algorithms, processes, theory.
- Analysis.
- Publications.

# Back to school

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- Technological training/Continuing education.
- Specialization.
- Master's Degree Course.
- PhD/Doctor Degree Course.

# Concluding remarks

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- Strong fundamental courses.
- Undergraduate research opportunities.
- Research and development projects.
- Major Bachelor Dissertation.
- Graduate or continuing education.