

EE 1322: Intro to Electrical & Computer Engineering

Module 2: ECE—Past, Present, and Future

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1. How did ECE become a field? *The Past*
2. What are the main ECE concentrations? *The Present*
3. How will ECE evolve? *The Future*

Part 1:

ECE: The Past

- Anthropocene: fancy word
 - the current geological age, viewed as the period during which human activity has been the dominant influence on climate and the environment
- ECE-based inventions defined the Anthropocene—in every way
 - Some inventions came at a great environmental cost
 - Some resulted in saving millions of lives
- When one creates a technology, they need to be aware of what it might cause
 - Cannot simply say “I don’t care” or “I didn’t know this could harm people”
 - Recklessness is not an excuse
- ECE (a past/present view of the field):
 - The field that studies electricity, electromagnetism, communications, energy, power, computer engineering
 - The field is continuously evolving
 - Hard to predict where it’s heading, but will remain a highly decorated field

ECE: A brief timeline (1600-1800)

Timeline (1600-1800)



William Gilbert
(England)

1600

Versorium:
Detection of static
electric charge



- *De Magnete (On the Magnet)*
- Father of ECE



Alessandro Volta
(Italy)

1762

Electrophorus:
Production of
electrostatic charge



- Invention of the battery
- Honestly, that's dubious



**Charles-Augustin
de Coulomb**
(France)

1783

Coulomb's Law

$$F = k_e \frac{q_1 q_2}{r^2}$$

- First experimental law to quantifies the amount of force between two stationary, electrically charged particles

ECE: A brief timeline (1800-1850)

Timeline (1800-1850)



Hans Christian Orsted
(Denmark)

1820

Observed that electric current creates magnetism

- First connection found between electricity and magnetism



André-Marie Ampère
(France)

1820

Ampere's Law
 $F = qv \times B$

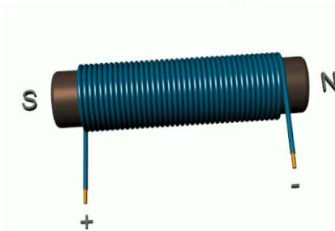
- A week after Orsted's discovery



William Sturgeon
(England)

1825

First Electromagnet



- Electromagnet is a type of magnet in which the magnetic field is produced by an electric current.



Georg Simon Ohm
(Germany)

1827

Ohm's Law

- Ohm introduced the concept of electrical resistance
- Electrical resistance of an object is a measure of its opposition to the flow of electric current.

ECE: A brief timeline (1800-1850)

Timeline (1800-1850) cont..



Michael Faraday
(England)

1831

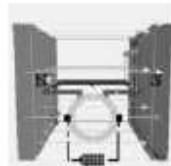
Laws of
Induction



Joseph Henry
(America)

1831

Prototype DC
motor



Hippolyte Pixii
(France)

1832

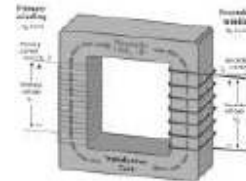
DC generator



Nicholas Joseph
Callan
(Ireland)

1836

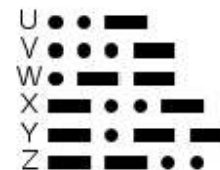
Transformer



Samuel Finley
Breese Morse
(America)

1844

Morse Code

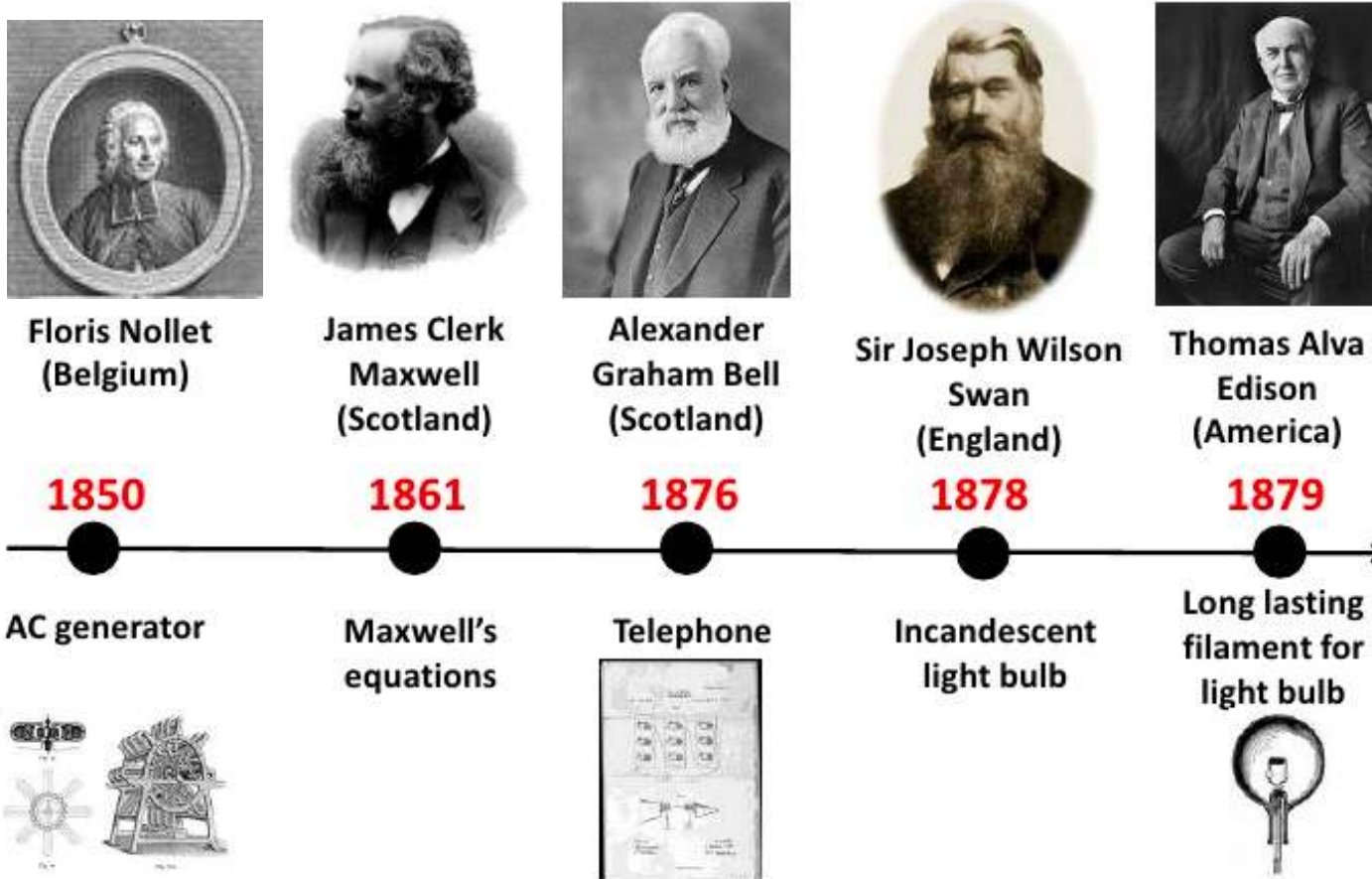


- Law predicting how a magnetic field will interact with an electric circuit to produce an electromotive force aka electromagnetic induction
- That's how we get electricity!

- DC generator: device that converts mechanical power into electrical
- Sources of mechanical energy: steam turbines, gas turbines, water turbines, wind
- Generators provide nearly all power for power grids

ECE: A brief timeline (1850-1900)

Timeline (1850-1900)



- Set of coupled differential equations that form the foundation of classical electromagnetism, classical optics, and electric circuits.

ECE: A brief timeline (1850-1900)

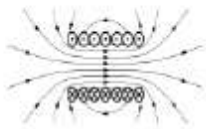
Timeline (1850-1900) cont..



Heinrich Rudolf
Hertz
(Germany)

1888

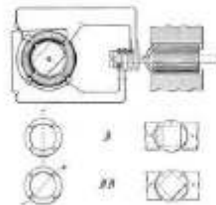
Electro-
magnetic
wave



Nikola Tesla
(Serbia-America)

1888

AC motor



Thomas Alva
Edison
(America)

1890

Fuse



Alexander
Stepanovich
Popov
(Russia)

1894

Radio receiver



Karl Ferdinand
Braun
(Germany)

1897

Cathode Ray
Oscilloscope



- Father of communications
- Electromagnetic refers to the waves of the electromagnetic field, propagating through space carrying electromagnetic radiant energy
- Includes radio waves, microwaves, X-rays
- AC motor: electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field
- Can be made without wires!

ECE: A brief timeline (1900-2000)

Timeline (1900-2000)



Sir Jagadish
Chandra Bose
(India)

1895

Wireless
radio
transmission



Guglielmo
Marconi
(Italy)

1901

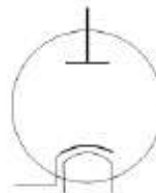
transatlantic
radio broadcast



Sir John Ambrose
Fleming
(England)

1904

Diode



Lee de Forest
(America)

1906

Triode



Edwin Howard
Armstrong
(America)

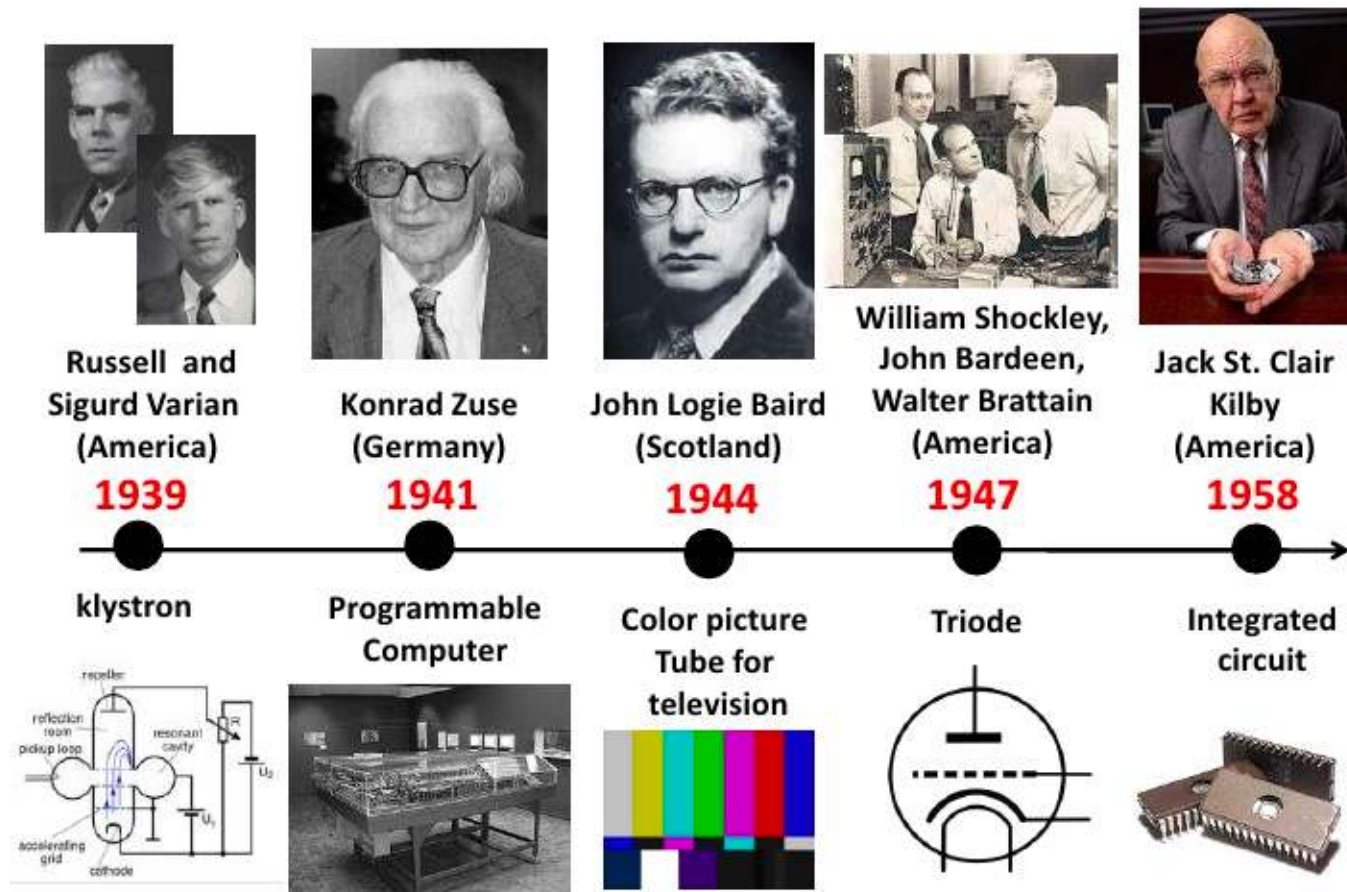
1912

Electronic
Oscillator

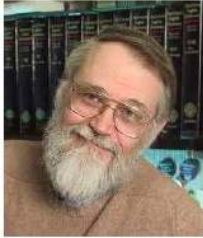
- This enabled modern electronics as we know them today

ECE: A brief timeline (1900-2000)

Timeline (1900-2000) cont..



Some ECE grads



Brian Kernighan

Co developer of Unix



Hewlett and Packard

founders of HP



Celebrating 40 years uptime

...is an Electrical Engineer

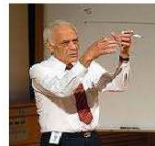


...are Electrical Engineers



Amar Gopal Bose

founder and chairman of Bose Corporation



Alfred Hitchcock

British film director and producer



...is an Electrical Engineer



...was an Electrical Engineer

Gender and race disparity



- You probably have already observed that most of prominent ECE inventions and graduates are males and whites
- Why is that so?
 - Gender and race disparity
 - Colonialism
 - Neo-liberalism
 - Slavery
 - Anti-women policies
 - Military destruction and occupation of sovereign nations
 - Systemic injustices, voter suppression, segregated communities
 - And many reasons
- Your role is to change, alter these brands of power
- A single race or gender should not dominate a discipline
 - It's counterproductive, evil, and should be eradicated
- We need to give equal opportunity to everyone

- The field has changed dramatically in the past few years
- Major changes:
 - More machine learning and AI at the center of ECE and all high techs
 - More biomedical engineering + ECE → advances in human health
 - Improved communication allowing for a better life
 - High-speed internet, fiber optics, wireless networks, internet-of-things, 5G networks and beyond
 - Automation and robotics
 - Material science and engineering
 - Cyber-security
 - Programming
 - Climate change and power systems
 - Renewable energy sources
 - Sensing and actuation technologies

ECE: the present at UTSA



- Our program objective at UTSA is to teach you the fundamentals
- It's virtually impossible to teach you everything in four years
- We teach and train you in
 - Electronics
 - Power and energy systems
 - Communications
 - Control systems
 - Electromagnetics
 - Signals and image processing
 - Computer engineering
 - Programming and data structures
- We also teach you a good amount of math, general engineering, and many other skills you need at the workplace
- Don't think yourself of only as an engineer—it's very reductive

- There's few things you cannot do with a degree in ECE
- I finished my undergrad in 2011 and my classmates are:
 - Professors
 - Scientists
 - Consultants
 - Bankers
 - Politicians
 - Lawmakers
 - Energy systems engineers
 - Biomedical engineers
 - Engineers at Apple, CISCO, Tesla, Microsoft, SpaceX, Uber, Lyft, ...
- Think of your degree as a solid basis for which you can build on
- Your degree will *not* define you
 - Your hard work, honesty, ethics, curiosity, kindness, compassion will

- Great challenges require great changes to how we do things
- Electrical and computer engineering in the future will be different
- Why?
 - Climate change and global warming
 - Security and privacy
 - Fake everything—news, pictures, videos
 - E-currencies
 - Elections
 - Banking
 - Communications
 - Video games
 - Infrastructures
 - ...
- Challenges that require ECE graduates to work on increasingly multi-disciplinary studies

What does an ECE degree offer that other engineering degrees cannot offer?

- More analytical thinking
- Excellent programming skills
 - Many engineering jobs require that these days...having that is a big plus
- Stronger mathematical skills
 - All high tech relies on advanced mathematics
 - ECE courses rely on math (besides some classes on computer engineering)
- Solving challenging engineering problems that require abstraction
- A wide variety of expertise that other engineers might not have
 - For example, civil engineers' focus is on a narrower set of topics
 - Mechanical engineers study narrower scope as well
 - But ECE's study broad yet still detailed disciplines
- My experience as an ECE undergrad, grad student, and a professor
 - Do I really have a lot of background in all ECE topics? Not really
 - I found a niche and I enjoyed it
 - Do the same: be good at everything, but excel at 1-2 ECE topics!
 - And remember, it's never too late to change topics/focus

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