A Simplified History of

Fundamentals of Electrical and Computer Engineering

18 August 2025

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1. The Early Years: Foundations in Physics and Mathematics (1600s–1880s)

The story of ECE begins with the very human curiosity about electricity and magnetism. For centuries, these phenomena were seen as little more than scientific curiosities.

Early Discoveries and the Birth of a New Science

- **1600s-1700s: Static Electricity** – Early scientists like **William Gilbert**, who coined the term "electricity" from the Greek word for amber, meticulously documented the properties of static electricity and magnetism. Later, **Benjamin Franklin** conducted his famous kite experiment in the 1750s, demonstrating that lightning was a form of electricity and proposing the concepts of positive and negative charges.
- **1800-1820: Current and Batteries** – The invention of the **voltaic pile** by **Alessandro Volta** in 1800 provided the first steady source of electric current. This spurred a flurry of research. **Hans Christian Ørsted** in 1820 discovered that an electric current creates a magnetic field, a finding that linked electricity and magnetism and laid the groundwork for electromagnetism.
- **1826-1831: Ohm's Law and Induction** – **Georg Ohm** published his famous law in 1827, which established the fundamental relationship between voltage, current, and resistance (V=IR). Around the same time, **Michael Faraday** built on Ørsted's work. His experiments with moving magnets and coils of wire led to the discovery of **electromagnetic induction** in 1831. This was a monumental discovery, showing that a changing magnetic field could induce an electric current, a principle that underpins all electric generators and transformers.

The Rise of Telecommunications

- **1830s-1870s: The Telegraph** – Building on these discoveries, **Samuel Morse** and **Alfred Vail** developed a practical electric telegraph system in the 1830s. The invention of the **Morse code** provided a simple, effective way to transmit messages over long distances. The first telegraph line was completed in 1844, linking Washington D.C. and Baltimore. The rapid expansion of telegraph networks created the first widespread need for what we would now call electrical engineers.
- **1876: The Telephone** – **Alexander Graham Bell** filed the patent for the telephone in 1876, creating a new and far more personal form of communication. This invention required a more complex understanding of sound waves and their conversion into electrical signals, and its commercial success led to the founding of companies like Bell Telephone Company (later AT&T).

2. The Age of Power and Light (1880s-1920s)

This era was defined by the transition from scientific curiosity to the widespread application of electricity in everyday life. It was a period of intense competition and rapid innovation.

The War of the Currents

- **Direct Current (DC)** – **Thomas Edison** was the champion of direct current. He developed a practical incandescent light bulb in 1879 and built the first commercial power plant in New York City in 1882. His vision was a network of small, local power plants that supplied DC power to nearby customers. However, DC had a major limitation: it was difficult to transmit over long distances without significant power loss.
- **Alternating Current (AC)** – **Nikola Tesla**, a former employee of Edison, championed alternating current. Working with **George Westinghouse**, he developed AC motors, generators, and transformers. AC power could be "stepped up" to high voltages for efficient long-distance transmission and then "stepped down" at the point of use.
- **Victory for AC** – The "War of the Currents" was a bitter public relations battle. Edison tried to discredit AC by demonstrating its dangers, but the practical advantages of AC for a national power grid were undeniable. The **Niagara Falls power plant**, a large-scale AC project completed in 1895, proved the superiority of the system and cemented AC's role as the standard for power distribution.

Formalization of the Profession

- **Academic Discipline** – As electrical technology became a cornerstone of industry, universities began to establish dedicated departments. The **Massachusetts Institute of Technology (MIT)**, for example, founded its first electrical engineering course in 1882.
- **Professional Societies** – The **American Institute of Electrical Engineers (AIEE)**, a predecessor to the modern IEEE, was founded in 1884. These organizations were crucial for standardizing practices, sharing knowledge, and legitimizing the new profession.

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3. The Electronics Era and the Birth of Computing (1920s-1960s)

This period saw a shift from large-scale power systems to the control of electrical signals, a field that would become known as **electronics**. This was the fertile ground for the birth of the computer.

From Tubes to Transistors

- **The Vacuum Tube** – In the early 20th century, the **vacuum tube** became the central component of electronics. It was used to amplify signals in radios, televisions, and early computers. These devices were bulky, consumed a lot of power, and were prone to failure.
- **The Transistor Revolution** – The invention of the **transistor** in 1947 at **Bell Labs** by **John Bardeen**, **Walter Brattain**, and **William Shockley** changed everything. The transistor was a solid-state semiconductor device that could amplify or switch electronic signals. It was smaller, more reliable, and more energy-efficient than the vacuum tube. This discovery earned them the Nobel Prize in Physics in 1956 and is arguably the single most important invention in the history of ECE.

Early Computers

- **World War II and the Need for Calculation** – The war provided a major impetus for computer development. The US military needed to calculate complex ballistics trajectories, and Allied codebreakers needed to break enemy ciphers. This led to the creation of machines like the **Colossus** in Britain and the **ENIAC** in the US, which was completed in 1946. These were room-sized computers that relied on thousands of vacuum tubes.
- **The Stored-Program Concept** – **John von Neumann** developed the stored-program concept in the 1940s, a fundamental architectural breakthrough. Instead of being re-wired for each task, a computer could store both its instructions and its data in memory. This made computers flexible, programmable machines.

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4. The Microchip and the Personal Computer Revolution (1960s-1980s)

The invention of the microchip marked the point where electrical and computer engineering truly merged into a single discipline.

The Integrated Circuit

- **The Invention** – In 1958, **Jack Kilby** at Texas Instruments and **Robert Noyce** at Fairchild Semiconductor independently invented the **integrated circuit (IC)**, or microchip. They figured out how to place multiple transistors and other components on a single piece of silicon. This innovation solved the problem of connecting a huge number of discrete components, which was becoming a major bottleneck in computer design.

- **Moore's Law** – In 1965, **Gordon Moore**, a co-founder of Intel, made a famous prediction: the number of transistors on an IC would double approximately every two years. This observation, now known as **Moore's Law**, became a self-fulfilling prophecy and a driving force for the entire semiconductor industry. It guided research and development for decades, leading to an exponential increase in computing power and a corresponding decrease in cost.

The Personal Computer

- **The Rise of the Microprocessor** – The invention of the **microprocessor**—an entire computer's central processing unit on a single chip—in 1971 by Intel's **Marcian Hoff** made personal computers a reality. The **Intel 4004** was the first commercially available microprocessor.
- **The PC Revolution** – Companies like **Apple** and **IBM** introduced personal computers in the late 1970s and early 1980s, bringing computing power from large, institutional settings into homes and offices. This created an explosion of demand for both hardware and software, and ECE departments began to formally incorporate computer engineering as a core part of their curriculum.

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5. The Information Age: Networks, Mobile, and Beyond (1990s-Present)

The final decades of ECE history have been defined by the convergence of computing and communication, creating a globally connected world.

The Internet and Wireless

- **The World Wide Web** – While the internet's precursor, ARPANET, existed for decades, the invention of the **World Wide Web** in 1989 by **Tim Berners-Lee** made the internet accessible to the general public. This created a new need for high-speed network infrastructure, routers, and specialized hardware.
- **Wireless Communication** – The development of cell phones and wireless technologies like **Wi-Fi** and **Bluetooth** transformed how we communicate. This required ECE engineers to specialize in fields like **RF (radio frequency) engineering**, **signal processing**, and **antenna design**.

The Modern Landscape

- **The Smartphone** – The launch of the **iPhone** in 2007 was a watershed moment. It combined a computer, a communication device, a camera, and a multitude of sensors

into a single, pocket-sized device. The design of a modern smartphone requires expertise in nearly every sub-field of ECE, from power management and user interface design to wireless communication and embedded systems.

- **New Frontiers** – Today, ECE is at the forefront of countless innovations. The field is pushing the boundaries of:
    - **Artificial Intelligence (AI)** and **Machine Learning**: Designing specialized hardware (like GPUs) to accelerate AI computations.
    - **The Internet of Things (IoT)**: Creating interconnected smart devices for homes, cities, and industries.
    - **Robotics**: Combining hardware and software to build intelligent, autonomous machines.
    - **Biomedical Engineering**: Developing medical devices like pacemakers and prosthetics.
    - **Renewable Energy**: Designing smart grids and optimizing solar and wind power systems.

The history of ECE is one of continuous evolution, from the theoretical musings of physicists to the practical application of power and communication, and finally to the seamless integration of computing into every aspect of our lives.

Notes:

1. Review more details of the engineering keywords (including person names) in the given text above using AI, such as ChatGPT, Gemini AI, or Grok.
2. For each of you, choose a topic from the text that you are interested in, then explore the topic.
3. Write down the topic you choose into a 6 pages (normal MS word format, including pictures, illustrations, figures, etc.) article in Bahasa Indonesia.
4. Submit the article to ethol.pens.ac.id platform. Deadline for submission 24 august 2025.