

PHAS2201 - Electricity and magnetism

Lecturer: Dr. F. Renzoni

Contact hours:

Monday: 12:30-14:00 (room F21)

Textbooks:

R.A. Serway and J.W. Jewett, Jr
Physics for Scientists and Engineers

1

1 Milestones in Electromagnetism

Electric charge ≈ 700 BC

Electricity has been known of for a long, long time. The ancient Greeks were aware that when samples of amber were rubbed with wool or fur they acquired the ability to attract light objects such as feathers. It is from the Greek name of yellow amber (elek-

Figure 1: Amber

tron) that the word Electricity was created.

Benjamin Franklin (≈ 1750)

Benjamin Franklin shows that lightning is electricity (1752).

Coulomb's law (1777)

Charles Augustin de Coulomb, invented the torsion balance which could measure electrostatic force. Coulomb discovered that the force of repulsion was inversely proportional to the square of the distance between the centers of the two charges.



Figure 2: Coulomb's torsion balance

2

Magnetic forces (1820s)

1820 – Hans Christian Oersted discovers that electric current in a wire causes a compass needle to orient itself perpendicular to the wire.

1820 – Andr e Marie Amp re, one week after hearing of Oersted's discovery, shows that parallel currents attract each other and that opposite currents repel.

1820 – Jean-Baptiste Biot and Felix Savart establish the law governing the force exerted on a compass by a current carrying wire.

Electromagnetic induction, Faraday (1831)

In 1831 Faraday discovers electromagnetic induction and devises the first electrical generator. Faraday showed that a transient flow of current occurred in a closed circuit when the magnetic flux through the circuit was changed. In practice, this can be realized by moving a permanent magnet near the coil, or vice-versa.

Faraday also introduced the concept of field lines.

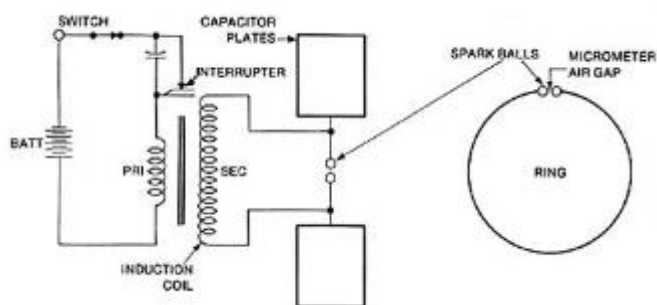
The unit of capacitance, the farad is named after him.

Maxwell's equations (1860s)

James Clerk Maxwell completes his formulation of the field equations of electromagnetism, now known as Maxwell's equations.

Hertz's oscillating dipole experiment (1888)

In 1888 Hertz generated electric waves using an electric circuit; the circuit contained a metal rod that had a small gap at its midpoint, and when sparks crossed this gap violent oscillations of high frequency were set up in the rod. Hertz proved that these waves were transmitted through air by detecting them with another similar circuit some distance away. He also showed that like light waves they were reflected and refracted and, most important, that they traveled at the same speed as light but had a much longer wavelength. These waves, originally called Hertzian waves but now known as radio waves,



conclusively confirmed Maxwell's prediction on the existence of electromagnetic waves, both in the form of light and radio waves. In recognition of Hertz' work, his name is now given to the unit of frequency - one cycle per second - (Hertz) and is abbreviated Hz.

Invention of wireless communication

Guglielmo Marconi extended Hertz's experiments in transmitting wireless sign and developed wireless communication. In 1896, Marconi took out his first patent for wireless.

One year later, he sent a message across the Bristol Channel. In 1899, he communicated across the English Channel. The same year saw the wireless telegraph being used to save a ship in distress in the North Sea.

On 12th December, 1901, the Marconi team successfully communicated across the Atlantic Ocean.

In 1909, Marconi was awarded the Nobel Prize for Physics as recognition for his work on wireless telegraph