

2201 – Electricity and Magnetism

I - Milestones in electromagnetism [1]

Coulomb's torsion balance and the inverse square law of electric charges. Biot-Savart law governing the force between a straight conductor and a magnetic pole. Introduction of the concept of field by Faraday. Maxwell's equations. Hertz's oscillating dipole experiment. Invention of wireless communication.

II - Electrostatics [6]

Coulomb's law; electric field; Gauss' law; superposition principle; electric field for a continuous charge distributions and electrostatics in simple geometries (spherical, cylindrical and planar distribution of charges). Gauss' law in differential form. Electric potential; electric field as gradient of the potential; electric potential for a point charge; electric potential for a discrete charge distribution; electric dipole; potential of a continuous charge distribution. Electrostatic energy; energy for a collection of discrete charges, and for a continuous charge distribution.

III - Conductors [3]

Electric field and electric potential in the cavity of a conductor; fields outside charged conductors; method of images. Vacuum capacitors: definition of capacitance; parallel plates, spherical and cylindrical capacitors; capacitors in series and parallel; energy stored in a capacitor.

IV - Dielectrics [1]

Dielectrics: definition and examples. Energy of a dipole in an electric field. Dielectrics in capacitors: induced charge, forces on dielectrics in non-uniform fields.

V - DC circuits [3]

Current and resistance; Ohm's law; electrical energy and power. DC circuits: emf, Kirchoff's rules. Examples.

VI - Magnetostatics [5]

Magnetic field, motion of a charged particle in a magnetic field and Lorentz force. Velocity selector, mass spectrometer, Hall effect. Ampere's law and Biot-Savart law. Magnetic field due to a straight wire, a solenoid, a toroid and a current sheet. Magnetic force between current carrying wires. Energy of a magnetic dipole in a uniform field.

VII - Electromagnetic induction [4]

Magnetic flux. Gauss' law for magnetism. Ampère-Maxwell law. Faraday's law of electromagnetic induction. Examples of emf generated by translating and rotating bars. Lenz's law of electromagnetic induction; electric generators; self inductance and mutual inductance; self inductance of a solenoid; back emf; eddy currents. Faraday's law in differential form. Transients in RLC circuits. Energy in the magnetic field.

VIII - AC circuits [3]

AC generators and transformers; circuit elements (R,C,L); impedance, complex exponential method for LCR circuits: the RC circuit, the RL circuit and the RLC circuit. Resonances, energy and power in the RLC circuit.

IX - Maxwell's equations [1]

Maxwell's equations in vacuo and plane wave solution.