Outline (PHY 1211-CSE-2021)

Note

Please follow all the class test questions and mathematical problems. Newly added topics are in bold letter.

Chapter 1

definition: Electric dipole, dipole moment
expression of electric field due to a dipole: $E = \frac{1}{2\pi\epsilon_0}\frac{p}{z^3}$
The torque on an electric dipole of dipole moment $\vec{p}$ when placed in an external electric field $\vec{E}$: $\vec{\tau} = \vec{p} \times \vec{E}$
A potential energy U is associated with the orientation of the dipole moment in the field: $U = -\vec{p}.\vec{E}$
State and explain Gauss's law
The electric field at any point due to an infinite line of charge with uniform linear charge density λ is perpendicular to the line of charge and has magnitude: $E = \frac{\lambda}{2\pi\epsilon_0 r}$
The electric field due to an infinite nonconducting sheet with uniform surface charge density σ is perpendicular to the plane of the sheet and has magnitude: $E = \frac{\sigma}{2\pi\epsilon_0}$
The electric field outside a spherical shell of charge with radius R and total charge q is directed radially and has magnitude: $E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$
The field inside a uniform spherical shell: $E = 0$

Chapter 2

Definition of capacitance, Practical unit of capacitance, independence of capacitance on charge and voltage.
capacitance of parallel plate capacitor (page 4-5: $C = \frac{\epsilon_0 A}{d}$)
Energy stored in an electric field (page 6-7: derivation of equation: $U = \frac{1}{2}CV^2$ and $u = \frac{1}{2}\epsilon_0 E^2$)
problem: sample problem -25.04, page 8
Effect of dielectric material on the capacitance: page 9-11
Effect of dielctric on the electric field: page 11-12.
Definition of polar and non-polar dielectrics.
Derivation of Gauss's law with dielectrics: $\epsilon_0 \int \kappa\vec{E}.d\vec{A} = q$ (page 13-14)
Problem: Sample Problem 25.06, page 14-15.
Definition of current.
Definition of **current density**, resistivity and derivation of equation $\vec{J} = (ne)\vec{v}_d$, (page 20-21)
Electron theory of conductivity: derivation of equation $\rho = \frac{m}{ne^2\tau}$. (page-22-23)
Problem: Sample problem 26.05 (page 23)

Chapter 3

Statement and explanation of Faraday's law and Lenz's law
Definition of self and mutual induction.
statement and explanation of Ampere's law.
Magnetic Field Outside a Long Straight Wire with Current, $B = \frac{\mu_0 i}{2\pi R^2} i$ page-845
Moving coil galvanometer and its working principle; current and charge sensitivity. page - 345
conditions for which a galvanometer is dead beat or ballistic.

Faraday's Law of Induction

The magnitude of emf $\mathscr{E}$ induced in a conducting loop is equal to the rate at which the magnetic flux ϕ_B through the loop changes with time,

$$\mathscr{E} = -\frac{d\Phi_B}{dt}. \tag{1}$$

$\mathscr{E}$ is the work done per unit charge in moving the test charge around the path and thus can be written as

$$\mathscr{E} = \frac{1}{q_0} \oint \mathbf{F} \cdot d\mathbf{l} = \oint q_0 \mathbf{E} \cdot d\mathbf{l} = \oint \mathbf{E} \cdot d\mathbf{l}$$

Equation 1 can now be written as

$$\oint \mathbf{E} \cdot d\mathbf{l} = -\frac{d\Phi_B}{dt}. \tag{2}$$

This is the integral form of Faraday's law of induction. By applying Stokes' theorem, we can write

$$\int (\nabla \times \mathbf{E}) \cdot d\mathbf{A} = -\frac{d}{dt} \int \mathbf{B} \cdot d\mathbf{A} = -\int \frac{\partial \mathbf{B}}{\partial t} \cdot d\mathbf{A},$$

so that

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}. \tag{3}$$

A changing magnetic field produces an electric field.

Chapter 4

Procedure of removing a voltage and a current source from a network
Kirchhoff's current and voltage laws
Statement of the theorem(Superposition, Millman, Reciprocity, Thevenin, Norton, Maximum power transfer).
procedure(Superposition, Millman, Reciprocity, Thevenin, Norton, Maximum power transfer).
problems (Class lecture)

Chapter 5

For the charging of a capacitor in RC ckt, show that $q = c\mathscr{E}(1 - e^{-t/RC})$
capacitive time constant, τ_c. Show that it has the dimension of time
For the discharging of a capacitor in RC ckt, show that $q = c\mathscr{E}e^{-t/RC}$
Problems: example 28.9, 28.10 For RL ckt, $\frac{\mathscr{E}}{R}(1 - e^{-Rt/L})$
Inductive time constant, τ_L.
Problems: example 32.2
Equation of motion DC series RLC ckt and the conditions of damping. specially, the light damping discussion on series RLC ac ckt including resonance.
Sample problem 31-06