Chapter-6: Electromagnetic Induction

1. Magnetic flux

$$\varphi = BS\cos\theta$$

Or

$$\varphi = \vec{B}\cdot\vec{S}$$

2. Gauss's law of magnetism

$$\oint \vec{B}.\overrightarrow{dS} = 0$$

3. Faraday's law of electromagnetic induction

$$e = -N\frac{d\varphi}{dt}$$

4. Induced current

$$i = \frac{e}{R} = \frac{1}{R}\left(\frac{-d\varphi}{dt}\right)$$

5. Motional emf

$$e = vbL\sin\theta$$

(Where θ = angle between conductor velocity and length of conductor from vertical)
If $\theta = 90^0$, then

$$e = vbL$$

6. Current induced in the loop:

$$i = \frac{e}{R} = \frac{vBl}{R}$$

7. Force experienced in the movable conductor of length l carrying current I, is given by

$$F = Ilb\sin 90^0 = IlB = \frac{vBl}{R}(lB) = \frac{B^2l^2v}{R}$$

8. If r is the internal resistance of the battery then, the current in the circuit is,

$$i = \frac{e}{R+r} = \frac{vBl}{R+r}$$

9. Power delivered by the external force:

$$P_{del} = Fv = \frac{B^2l^2v}{R}v = \frac{B^2l^2v^2}{R}$$

10. If a conductor is moving in a circular path with one end fixed at the centre of the circle, then Induced emf across the conductor

$$e = \frac{1}{2}B\omega L^2$$

Or

$$e = \pi f B L^2$$

11. Self-inductance of a coil

$$L = \frac{N\varphi}{I}$$

And

$$L = \left|\frac{-e}{\frac{dI}{dt}}\right|$$

Or

$$e = -L\frac{dI}{dt}$$

PD across a coil

$$v = -e = L\frac{dI}{dt}$$

12. Self-inductance of the solenoid

$$L = \frac{\mu_0 N^2 A}{l}$$

13. Energy (potential energy) stored in an inductor in magnetic field,

$$U = \frac{1}{2}Li^2$$

14. Energy density in magnetic field,

$$u = \frac{U}{V} = \frac{1}{2}\left(\frac{B^2}{\mu_0}\right)$$

15. Mutual Inductance (M):

$$M = \frac{N_2\varphi_2}{I_1}$$

Or

$$e_2 = -M\frac{di_1}{dt}$$

16. Mutual Inductance between two coaxial solenoids

$$M = \frac{\mu_0 N_1 N_2 A}{l}$$