Physics Formula's class : 12

L.No-1 – Electrostatics

- Coulomb's law [Electrostatic force b/w two charges] ⇒ $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$
- Electric field ⇒ $E = \frac{F}{q}$ $\left[\frac{N}{C} \text{ (or) } NC^{-1}\right]$
- Electric field due to a point charge $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$
- Electric dipole moment $p = q \times 2a$
- Axial line $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3}$
- Equatorial line $\vec{E} = -\frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}$
- Torque on Electric dipole in uniform Electric field $\tau = p \times E$, $\tau = pE\sin\theta$
- Electric potential due to point charge ⇒ $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$
- " due to an dipole ⇒ $V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}$
- Relation b/w Electric field and potential $E = -\frac{dV}{dx}$
- Electric flux $\phi_E = EA\cos\theta$

- Gauss law $\phi_E = \frac{q}{\varepsilon_0}$
- E.F due to long charged wire $E = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$
- " " ∞ plane sheet $E = \frac{\sigma}{2\varepsilon_0}$
- " Two parallel charged ∞ sheet $E = \frac{\sigma}{\varepsilon_0}$
- E.F due to charged spherical shell
  - i) outside the shell $E = \frac{q}{4\pi\varepsilon_0 r^2}$
  - ii) inside the shell $E = 0$
  - iii) surface of the shell $E = \frac{q}{4\pi\varepsilon_0 R^2}$
- Capacitance of parallel plate capacitor $C = \frac{\varepsilon_0 A}{d}$ (or) $C = \frac{q}{V}$
- Energy stored in a capacitor $U_E = \frac{q^2}{2C} = \frac{1}{2}CV^2$
- Capacitor in series $\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
- Capacitor in parallel $C_p = C_1 + C_2 + C_3$

L.No.2 – Current Electricity

- current $I = \frac{q}{t}$
- Drift velocity $v_d = -\mu E$ (or) $v_d = -\frac{e\tau}{m}E$
- mobility $\mu = \frac{|v_d|}{|E|}$ ⇒ unit ⇒ $m^2V^{-1}s^{-1}$
- microscopic model of current $I = neAv_d$
- current density $J = \frac{I}{A}$ (A) (or) Am^{-2}

(3)
- ohm's law $V = IR$
- microscopic form of ohm's law $J = \sigma E$
- Resistivity of the material $R = \rho \frac{l}{A}$
- Resistance are in series $R_s = R_1 + R_2 + R_3$
- Resistance are in parallel $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
- Temperature co-efficient of Resistivity } $\alpha = \frac{\rho_T - \rho_0}{\rho_0 (T - T_0)} = \frac{\Delta\rho}{\rho_0 \Delta T}$
- Resistance of the conductor at $T^0 C$ } $R_T = R_0[1 + \alpha(T - T_0)]$
- Electrical conductivity $\sigma = \frac{ne^2\tau}{m}$
- Electrical Resistivity $\rho = \frac{m}{ne^2\tau}$
- Electrical power $P = VI = \frac{V^2}{R} = I^2 R$
- Internal Resistance $r = \left[\frac{\varepsilon - V}{V}\right] R$
- wheatstone's bridge $\frac{P}{Q} = \frac{R}{S}$
- meter Bridge $P = Q \frac{l_1}{l_2}$
- comparision of emf of Two cells $\Rightarrow \frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$
- Internal Resistance of a cell by potentiometer } $r = R\left[\frac{l_1 - l_2}{l_2}\right]$
- Joule's law of Heating $H = I^2 R t$

Colour code of Carbon Resistor

B - 0 - Black
B - 1 - Brown
R - 2 -
O - 3 -
Y - 4 -
G - 5 -
B - 6 -
V - 7 -
G - 8 -
W - 9 -
Au - 5%
Ag - 10%
colourless - 20%

(4) L.No.3 magnetic Effect of I

- magnetic field $B = \frac{F}{q_m}$ $[N A^{-1} m^{-1}]$
- magnetic flux $\phi_B = BA\cos\theta$
- Torque on Barmagnet $\tau = P_m B \sin\theta$
- magnetic moment $P_m = q_m 2l$
- Biot savart law $dB = \frac{\mu_0}{4\pi} \frac{I\,dl \sin\theta}{r^2}$
- " " in vector form $d\vec{B} = \frac{\mu_0}{4\pi} \frac{I\,d\vec{l} \times \vec{r}}{r^2}$
- $\vec{B}$ due to long stright I carrying conductor } $B = \frac{\mu_0 I}{2\pi a}$
- " " circular coil $B = \frac{\mu_0 N I}{2R}$
- Ampere circuital law $\oint B \cdot dl = \mu_0 I_{enclosed}$
- $\vec{B}$ due to I carrying wire by Ampere circuital law } $B = \frac{\mu_0 I}{2\pi r}$
- $\vec{B}$ due to long solenoid $B = \mu_0 n I \Rightarrow$ Toroid also same
- Lorentz force $F = q(\vec{v} \times \vec{B})$
- Force on a conductor placed in $\vec{B}$ $F = BIl\sin\theta$
- " on Two parallel I carring conductor } $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$
- current sensitivity $I_s = \frac{\theta}{I} = \frac{n}{G}$
- voltage sensitivity $V_s = \frac{I_s}{R_G}$

- equatorial line of " $\vec{B} = -\frac{\mu_0}{4\pi} \frac{p_m}{r^3}$
- magnetic permeability $\mu_r = \frac{\mu}{\mu_0}$
- Intensity of magnetisation $\vec{M} = \frac{p_m}{V}$ (or) $\frac{q_m}{A}$
- magnetic Induction (or) Total magnetic field } $B = B_0 + B_m = \mu_0(H+M)$
- magnetic susceptibility $\chi_m = \frac{M}{H}$

Dia	Para	Ferro
$\chi_m \to -ve$	$\chi_m \to +ve$ small	$\chi_m \to +ve$ large
$\mu_r < 1$	$\mu_r > 1$	$\mu_r >> 1$
$\chi_m \to$ Temp independ	$\chi_m \propto \frac{1}{T}$	$\chi_m \propto \frac{1}{T}$

- curie's law $\chi_m = \frac{C}{T}$
- curie-weiss law $\chi_m = \frac{C}{T-T_C}$
- Fleming Left Hand Rule ⇒ F, F, C
- Galvanometer to Ammeter $I_g = \frac{S}{S+R_g} I$, $I_g \propto S$
- Galvanometer to voltmeter $I_g = \frac{V}{R_g + R}$, $I_g \propto V$

- emf induced in the coil $\varepsilon = -N\frac{d\phi_B}{dt}$
- motional emf from Lorentz force $\varepsilon = Blv$

self induction	mutual induction
$L = \frac{N\phi_B}{i}$	$M_{21} = \frac{N_2 \phi_{21}}{i_1}$
$\varepsilon = -\frac{d(Li)}{dt}$	$\varepsilon_2 = -\frac{d(M_{21} i_1)}{dt}$

- Energy stored in capacitor $U_E = \frac{1}{2}\frac{q^2}{C}$
- self induction of a long solenoid $L = \mu_0 n^2 A l$
- Energy stored in Inductor $U_B = \frac{1}{2} L i^2$
- mutual induction of long solenoid $M = \mu_0 n_1 n_2 A l$
- Emf by changing Area $\varepsilon = Blv$
- Emf by changing Relative orientation of the coil } $\varepsilon = \varepsilon_m \sin\omega t$, $I = I_m \sin\omega t$
- Efficiency of Transformer $\eta = \frac{\text{output}}{\text{Input}} \times 100\%$
- $\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s} = k$

step up Transformer (k>1)	step down Transformer (k<1)
$N_s > N_p$, $V_s > V_p$, $I_p < I_s$	$V_s < V_p$, $N_s < N_p$, $I_p > I_s$
voltage is (↑) increased	voltage is ↓
current is (↓) decreased	current is ↑
⇒ Generating stations	⇒ Receiving Station

* Average value of A.C $I_{av} = \frac{2I_m}{\pi} = 0.637 I_m$
* Rms value of A.C $I_{Rms} = 0.707 I_m$
* " $V_{Rms} = 0.707 V_m$

A.C with Resistor	A.C with Inductor	A.C with capacitor
$v = V_m \sin \omega t$	$v = V_m \sin \omega t$	$v = V_m \sin \omega t$
$i = I_m \sin \omega t$	$i = I_m \sin(\omega t - \pi/2)$	$i = I_m \sin(\omega t + \pi/2)$
v & i are in phase	* i lags v by $\pi/2$	* i leads v by $\pi/2$

* Resonant Angular frequency $\omega_r = \frac{1}{\sqrt{LC}}$ (or) $f_r = \frac{1}{2\pi\sqrt{LC}}$
* Q-factor $= \frac{\omega_r L}{R}$ (or) $\frac{1}{R}\sqrt{\frac{L}{C}}$
* Impedence $Z = \sqrt{R^2 + (X_L - X_C)^2}$
* Average power $P_{av} = V_{Rms} I_{Rms} \cos\phi$
* Power factor $= \frac{R}{Z}$ (or) $\frac{P_{av}}{V_{Rms} I_{Rms}}$ (or) $\frac{\text{True Power}}{\text{Apparent Power}}$

L.No.5 - Em waves

* Displacement current $I_d = \frac{dq}{dt}$
* maxwell modified Ampere's law (or) Ampere - maxwell law $\oint B \cdot dl = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$
* maxwell correction term $= \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$

maxwell's equations

1st equation	2nd equation
* Gauss law of electricity $\oint E \cdot dA = \frac{Q_{enclosed}}{\varepsilon_0}$	* Gauss law for magnetism $\oint B \cdot dA = 0$
3rd equation	**4th equation**
* Faraday's law of EmI $\oint E \cdot dl = -\frac{d\phi_B}{dt}$	* Ampere maxwell law $\oint B \cdot dl = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d}{dt}\oint E \cdot dA$

* speed of light - 3×10^8 m/s

Properties of Em waves

* produced by accelerated charges
* Non-mechanical,
* does not need any medium
* Transverse
* Not deflected by E & B field
* it carry energy & momentum

Em spectrum

Radio	micro	IR	visible	UV	X-ray	Gamma
10^9 Hz	$10^9 - 10^{11}$ Hz	$10^{11} - 4\times10^{14}$	$4\times10^{14} - 8\times10^{14}$	$10^{14} - 10^{17}$	$10^{17} - 10^{19}$	10^{18} Hz & above

Types of spectrum

Absorption ... Emission

- Angle of deveation $d = 180 - 2i$ (or) $d = 2\alpha$
- Relation b/w f & R $f = \frac{R}{2}$
- mirror equation $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$, magnifi $m = -\frac{v}{u}$, $m = \frac{f-v}{f}$ (or) $\frac{f}{f-u}$
- Lens equation $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, magni, $m = \frac{v}{u}$ (or) $\frac{f-v}{f}$ (or) $\frac{f}{f+u}$
- Refractive index of the medium $n = \frac{c}{v}$
- optical path $d' = nd$ (or) $d' = \frac{c}{v} d$
- snell's law $\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$
- critical Angle $\sin i_c = \frac{1}{n}$
- Lateral displacement $L = t\left[\frac{\sin(i-r)}{\cos r}\right]$
- power of a lens $P = \frac{1}{f}$
- Angle of deveation $d = i_1 + i_2 - A$
- Refractive index $n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$
- Dispersive power $\delta = (n-1)A$, $\omega = \frac{(n_V - n_R)}{n-1}$

- Intensity $I \propto A^2$, $A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}$
- Relation b/w phase & path difference $\phi = \frac{2\pi}{\lambda}\delta$
- young's double slit experiment, path differ $- \delta = d\sin\theta$
- Bright fringe $y_n = \frac{n\lambda D}{d}$
- Dark fringe $y_n = \frac{(2n-1)\lambda D}{2d}$
- Band width $\beta = \frac{\lambda D}{d}$
- condition for diffraction minimum 1st min $\rightarrow a\sin\theta = n\lambda$
- 2nd mini $\rightarrow a\sin\theta = 2\lambda$
- 3rd mini $\rightarrow a\sin\theta = 3\lambda$
- nth mini $\rightarrow a\sin\theta = n\lambda$
- condition for diffraction maximum
  - 1st max $a\sin\theta = \frac{3\lambda}{2}$
  - 2nd max $a\sin\theta = \frac{5\lambda}{2}$
  - nth max $a\sin\theta = \frac{(2n+1)\lambda}{2}$
- fresnel distance $z = \frac{a^2}{2\lambda}$
- Diffraction grating $\sin\theta = Nm\lambda$, $N = \frac{\sin\theta}{m\lambda}$, $\lambda = \frac{\sin\theta}{Nm}$
- Angular resolution $\theta = \frac{1.22\lambda}{a}$
- malu's law $I = I_0\cos^2\theta$
- Brewster's

L.No.8 - Dual Nature of Radiation & matter

- K.E and stopping potential $\frac{1}{2}mv_m^2 = eV_0$, $V_{max} = \sqrt{\frac{2eV_0}{m}}$
- photon of Energy $E = h\nu = \frac{hc}{\lambda}$
- Threshold wavelength $\lambda_0 = \frac{hc}{\phi_0}$
- work fun $\phi_0 = h\nu - K_{max}$
- Debroglie wavelength $\lambda = \frac{h}{p} = \frac{h}{mv}$, $\lambda = \frac{h}{\sqrt{2mK}}$ (or) $\frac{12.27}{\sqrt{V}}$ Å
- Cutt-off wavelength $\lambda_0 = \frac{12400}{V}$ Å
- De broglie wavelength $\lambda = \frac{h}{p}$
- De broglie wave length of e^- $\lambda = \frac{12.27}{\sqrt{V}}$ Å (or) $\lambda = \frac{h}{\sqrt{2mK}}$

L.No.9 Atomic & Nuclear Physics

- In J.J Thomson (or) e/m value - $1.7 \times 10^{11} \frac{C}{kg}$
- $e/m = \frac{2yE}{Cl^2B^2}$,
- Impact parameter $b = K\cot(\frac{\theta}{2})$
- Angular momentum quantization condition } $l = n\hbar$, $\hbar = \frac{h}{2\pi}$
- Radius of n^{th} orbit $mvr = l = n\hbar$; $r_n = \frac{\epsilon_0 n^2 h^2}{\pi m z e^2} = 0.529\, n^2$
- Energy of n^{th} orbit $E_n = \frac{-13.6}{n^2}$ eV
  - 1^{st} orbit (Ground state) $E_1 = -13.6$ eV
  - 2^{nd} orbit [1^{st} Excited state] $E_2 = -3.4$ eV
  - 3^{rd} orbit [2nd "] $E_3 = -1.51$ eV
- 1 amu $= 1.660 \times 10^{-27}$ kg
- Nuclear Radius $R = R_0 A^{1/3}$, $R_0 = 1.2F$, $1F = 10^{-15}$m
- Binding Energy per Nucleon $BE = \frac{[Zm_H + Nm_n - M_A]c^2}{A}$
- law of Radioactive decay $N = N_0 e^{-\lambda t}$
- No. of nuclei remaining undecayed } $N = \left[\frac{1}{2}\right]^n N_0$
- Half life time $T_{1/2} = \frac{0.6931}{\lambda}$
- mean life time $\tau = \frac{T_{1/2}}{0.6931}$
- Relation b/w $T_{1/2}$ & τ: $T_{1/2} = 0.6931\,\tau$

→ Millikan's oil drop experiment ... $E \left[\frac{\eta ...}{2(\rho-\sigma)g} \right]$

*) $r_n \propto n^2$, $v_n \propto n^{-1}$, $E_n \propto n^{-2}$ (or) $r_n \propto n^2$, $v_n \propto \frac{1}{n}$, $E_n \propto \frac{1}{n^2}$

*) $V_{ioni} = \frac{E_{ioni}}{e}$

Spectral series of H_2 atom

Lyman	Balmer	Paschen	Brackett	P-fund
$\bar{\nu} = R\left[\frac{1}{1^2} - \frac{1}{m^2}\right]$	$\bar{\nu} = R\left[\frac{1}{2^2} - \frac{1}{m^2}\right]$	$\bar{\nu} = R\left[\frac{1}{3^2} - \frac{1}{m^2}\right]$	$\bar{\nu} = R\left[\frac{1}{4^2} - \frac{1}{m^2}\right]$	$\bar{\nu} = R\left[\frac{1}{5^2} - \frac{1}{m^2}\right]$
U-V Region	visible	IR (Near)	IR (middle)	IR (Far)

*) Nuclear density $\rho = 2.3 \times 10^{17}\ kg\,m^{-3}$

Decay

α - decay	β - decay	γ - decay
${}_{Z}X^{A} \to {}_{Z-2}Y^{A-4} + {}_{2}He^{4}$	β^-, β^+ β^- - decay ${}_{Z}X^{A} \to {}_{Z+1}Y^{A} + e^- + \bar{\nu}$ β^+ - decay ${}_{Z}X^{A} \to {}_{Z-1}Y^{A} + e^+ + \nu$	${}_{Z}X^{A} \to {}_{Z}Y^{A*} + \gamma$

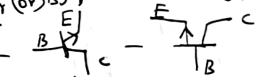
Semiconductor electronics & communications

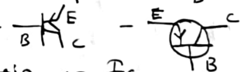
*) Resistivity of insulators – $10^{11} - 10^{19}\ \Omega m$
*) Resistivity of conductor – $10^{-2} - 10^{-8}\ \Omega m$
*) Resistivity of semiconductor – $10^{-5} - 10^{6}\ \Omega m$
*) Forbiden energy gap for silicon – 1.1 eV
*) " for Germanium – 0.7 eV

Potential barrier: Si – 0.7 V, Ge – 0.3 V

*) Energy of $\bar{e}$ is measured in eV [electron volt]
*) Knee voltage (or) Thresold voltage (or) cut in voltage
for Si – 0.7 V
for Ge – 0.3 V
*) Efficiency
*) Half wave Rectifier – 40.6 %
*) full wave Rectifier – 81.2 %

Transistor (or) BJT

1. NPN – 

2. PNP – 

*) Current gain $\alpha = \frac{I_C}{I_E}$, $I_E = I_B + I_C$
*) Relation b/w α and β
$\alpha = \frac{\beta}{1+\beta}$, $\beta = \frac{\alpha}{1-\alpha}$

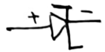
*) Blue LED – SiC
*) Green " – AlGaP
*) Red " – GaAsP
*) white " – GaInN

Transistor characterestics

1) I/p characterestics

$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$

*) I/P impedence is high

Diode	Zener Diode	Photo Diode
		

(15) Transistor characteristics

I/P	O/P	Transfer
• impedence is high • $r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$	impedence is low $r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_B}$	current gain β very high, ranges from 50 – 200 $\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$

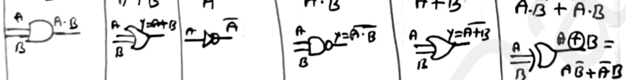
• Transistor oscillator frequency $f = \frac{1}{2\pi\sqrt{LC}}$

• Barkhausen condition $A\beta = 1$

Logic gates

1. AND
2. OR
3. NOT
4. NAND
5. NOR
6. EX-OR

AND	OR	NOT	NAND	NOR	EX-OR
•	+	o			
$A \cdot B$	$A+B$	$\overline{A}$	$\overline{A \cdot B}$	$\overline{A+B}$	$A\overline{B} + \overline{A}B$
A, B → $A \cdot B$	A, B → $Y = A+B$	A → $\overline{A}$	A, B → $Y = \overline{A \cdot B}$	A, B → $Y = \overline{A+B}$	A, B → $A \oplus B = A\overline{B} + \overline{A}B$



OR Laws	AND Laws	Commutative law	Associative Law	Distributive Law
$A + 0 = A$ $A + 1 = 1$ $A + A = A$ $A + \overline{A} = 1$	$A \cdot 0 = 0$ $A \cdot 1 = A$ $A \cdot A = A$ $A \cdot \overline{A} = 0$	$A + B = B + A$ $A \cdot B = B \cdot A$	$A + (B + C) = (A + B) + C$ $A \cdot (B \cdot C) = (A \cdot B) \cdot C$	$A(B + C) = AB + AC$ $A + BC = (A + B)(A + C)$

(16) Demorgan's Theorm

i) Ist Theorm

$\overline{A+B} = \overline{A} \cdot \overline{B}$

ii) 2nd Theorm

$\overline{A \cdot B} = \overline{A} + \overline{B}$

modulation

1. Amplitude modulation (Am)
2. Frequency modulation (Fm)
3. phase modulation (pm)

• Ground wave propagation – 2 KHz – 2 MHz

• Sky wave propagation – 3 MHz – 30 MHz

• Space wave propagation – 30 MHz – 400 GHz

• distance covered by the space wave propagation is → $d = \sqrt{2Rh}$

Diagram for practice

- *) Axial, equatorial line
- *) Electric potential due to dipole
- *) Applications of Gauss law
- *) Vandegraff Generator.
- *) Potentiometer
- *) meterbridge, wheatstone bridge
- *) $\vec{B}$ due to ∞ long straight conductor
- *) " ◯ → coil
- *) Force b/w Two ∥ conductors
- *) conversion of Ⓖ → Ⓥ → Ⓐ
- *) RLC
- *) Transformer
- *) Lens, mirror eqn diagram
- *) fizeau's method
- *) Prism → Refractive index
- *) Young double slit Experiment
- *) Brewster's law
- *) Diffraction at single slit
- *) Resolving power of microscope
- *) compound, Electron microscope
- *) Davision Germer Experiment
- *) J J Thomson, millikon's oil drop experiment
- *) H_2 spectral series
- *) Formation of PN Junction
- *) Half wave
- *) full wave
- *) Transistor switch
- *) Transistor characterestics
- *) Logic gates
- *) Fm, Am modulation
- *) Snell's window
- *) orientation of the coil
- *) Nuclear Reactor

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Work Hard in silence,
Let your success be your Noise.