MODEL SET-5

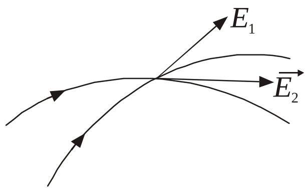
SECTION-II (NON-OBJECTIVE TYPE QUESTIONS)

Question Nos. 1 to 11 are of short answer type. Each question carries 2 marks. **11 × 2 = 22**

SHORT QUESTIONS

1. No two electric field lines can intersect each other. Why ?

Ans.—There would be two directions of electric field intensity at the same point it at the point of intersection it two electric lines of force intersect each other, which is not possible. Hence, no two electric field lines can intersect each other.



2. State Gauss's Theorem. Express it mathematically.

Ans.—Gauss's theorem—It states that "The total electric flux (ϕ) through any closed surface (s) is free space is equal to $\frac{1}{\epsilon_0}$ times the total electric charge (q) enclosed by the surface."

Mathematically, it can be expressed as

$$\phi = \oint_S \vec{E}.\overrightarrow{ds} = \frac{q}{\epsilon_0}$$

3. Differentiate between potentiometer and ordinary voltmeter.

Ans.—Following are the difference between Potentiometer and Ordinary voltmeter—

Potentiometer	**Ordinary voltmeter**
1. It works on null method.	1. It works on deflection method.
2. It is very accurate device.	2. It is an approximate instrument.

4. Calculate the resistance of two coils if their equivalent resistance in series and parallel are respectively 18Ω and 4Ω.

Ans.—Given that, R_S = 18Ω, R_P = 4Ω

R_1 = ?, R_2 = ?

As we know that,

$R_S = R_1 + R_2$

$18\Omega = R_1 + R_2$ …(1)

$$R_P = \frac{R_1 R_2}{R_1 + R_2}$$

As we have, $4 = \frac{R_1 R_2}{18}$ $\therefore$ $R_1R_2 = 4 \times 18 = 72\Omega$

$(R_1 - R_2)^2 = (R_1 + R_2)^2 - 4R_1R_2$
$= (18)^2 - 4 \times 72$
$= 324 - 288 = 36$

$\therefore \quad R_1R_2 = \sqrt{36} = 6\Omega$ …(2)

From eq^n (1) & (2), we get

$R_1 + R_2 = 18$
$R_1 - R_2 = 6$

$2R_1 = 24$

$$R_1 = \frac{24}{2} = 12\Omega$$

$R_1 + R_2 = 18$
$12 + R_2 = 18 \therefore R_2 = 18 - 12$
$R_2 = 6\Omega$

$\therefore \quad R_1 = 12\Omega$
$R_2 = 6\Omega$

5. The magnetic permeability of a substance is 7.5×10^{-3} TmA^{-1}. Then, find (i) relative permeability and (ii) magnetic susceptibility of the substance.

Ans.—Given that,

$\mu = 7.5 \times 10^{-3}$ TmA^{-1}

(i) As we know that,

$$\mu_r = \frac{\mu}{\mu_o}$$

$$= \frac{7.5\times10^{-3}}{4\pi\times10^{-7}} = \frac{7.15\times7\times10^{-3}}{4\times22\times10^{-7}\times10}$$

$$= \frac{15\times7\times10^{-3}\times10^{7}}{4\times22\times2} = \frac{15\times7\times10^{-4}}{4\times22\times2}$$

$$= \frac{15\times7\times100\times100}{4\times22\times2}$$

$$= \frac{105\times625}{11} = \frac{65625}{11}$$

$$\boxed{\mu_r = 0.6\times10^4}$$

(ii) $\mu_r = 1 + X_m$

$\therefore \quad X_m = \mu_r - 1$
$= 0.6 \times 10^4 - 1$
$= 6000 - 1$

$$\boxed{X_m = 5999}$$

6. Define inductive reactance (X_L). Write its S.I. unit and dimension.

Ans.—Inductive reactance (X_L)—It is the effective opposition offered by the inductor to the flow of current in the circuit. Its S.I. unit is ohm.

The dimension of inductive reactance is $[ML^2T^{-3}A^{-2}]$

It can be expressed as $\boxed{X_L = LW}$

7. Define mean value of a.c. and r.m.s. value of a.c. mention their expression only.

Ans.—Mean value of alternating current—It is that value of steady current which sends the same amount of charge through a circuit in a certain time interval as is sent by an a.c. through the same circuit in half cycle.

Its expression is as follows—

$$\boxed{I_{av} = \frac{2I_o}{\pi}}$$

$I_{av} = 0.637\ I_O$

Root Mean square Value of alternating current—It is that steady current which produces the same amount of heat in a conductor in a certain time interval as a produced by the a.c. in the same conductor during the time period, T. (it full cyle)

Its expression is as follows—

$$\boxed{I_{r.m.s.} = \frac{I_o}{\sqrt{2}}}$$

$I_{r.m.s.} = 0.707\ I_O$

8. A step up transformer is used on a 120V line to provide a potential difference of 2400V. If the primary has 75 turns, how many turns must the secondary have ?

Ans.—Given that,

$E_P = 120V$, $E_S = 2400$ V

$N_P = 75$, $N_S = ?$

We know that,

$$\frac{E_S}{E_P} = \frac{N_S}{N_P}$$

So, $$N_S = N_P \times \frac{E_S}{E_P}$$

$$= \frac{75 \times 2400}{120} = 1500$$

$$\boxed{N_S = 1500}$$

9. State two difference between interference and diffraction.

Ans.—Two differences between interference and diffraction are as follows—

	Interference		**Diffraction**
1.	It is due to the super position.	1.	It is due to the super position of secondary wavelets originating from the different points of the same wave front.
2.	In interferance patter, the dark fringes are usually almost perfectly dark.	2.	In diffraction pattern, the dark fringes are not perfectly dark.

10. State principle of reversibility of light. Define lateral shift.

Ans.—Principle of reversibility of light—If the path of a ray of light is reversed after suffering a no. of reflections and phenomena is called principle of reversibility of light. Briefly we may sat that—"The path of a ray of light is reversible."

Lateral shift—The ⊥' distance between the direction of incident ray and the emergent ray is known as the lateral shift.

11. Explain briefly—

(a) WWW

(b) FAX

Ans.—(a) WWW—It stands for world wide web. It is a collection of static and dynamic web pages containing information (text, pictures, viders, graphics etc) for sharing with others.

(b) FAX—It stands for facsimile telegraphy. In this form of communication, electronic copy of a document is sent to distant places. The original written document is converted into trasmittable codes at the sending end. These codes are converted back into a copy of the original document at the receiving end.

SECTION-II (NON-OBJECTIVE TYPE QUESTIONS)

Question Nos. 12 to 15 are of long answer type. Answer must be explantory and in your own language. Each question carries 5 marks. 4 × 5 = 20

LONG QUESTIONS

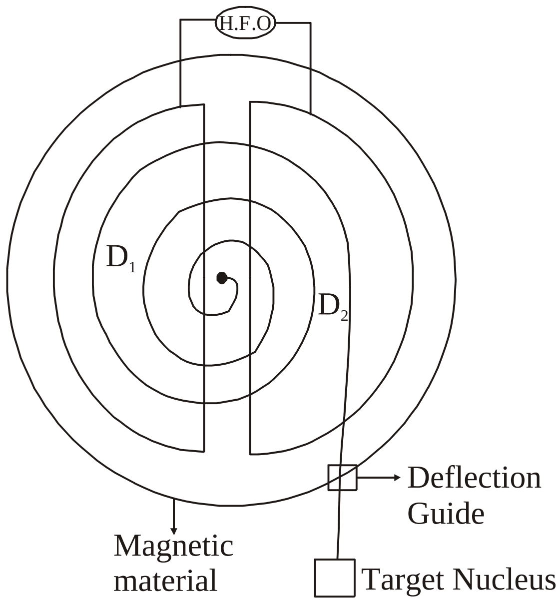
12. With the help of neat an labelled diagram explain the working of cyclotron. Deduce an expression for time period, frequency and total energy.

Ans.—Cyclotron—Cyclotron is a device which is used to acceerate positive charged particle such as proton, α-particle, electron etc. to acquire sufficient, amount of energy to carry out nuclear distintegration reaction.

Principle—

It is the particle application of cross-field. Cross field is that field in which electric field is perpendicular to the magnetic field.

Construction—



Let us consider a follow metallic chamber D_1 and D_2. D_1 is called left D and D_2 is called fight D. Both the dees are convert through high frequency oscillator called HFO.

The main function of HFO is to control the acceleration of positive charge partide. In follow space magnetic material is filled which produce the magnetic field.

Theory—

Necessary contripetal force is provided by lorentz magnetic force.

$$= F_C = f_B \quad \ldots(1)$$

$$= \frac{mv^2}{x} = 9vB\sin\theta \quad \ldots(2)$$

$$\theta = 90^o$$

$$= \frac{mv^2}{x} = 9vB\sin 90^o$$

$$= \frac{mv^2}{x} = 9vB$$

$$= \boxed{\nu = \frac{9Br}{m}} \quad \ldots(3)$$

For Dec—

(1) $$\text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{\pi x}{\frac{9Bx}{m}} = \frac{\pi m}{9B}$$

$$\therefore \quad \boxed{\text{Time} = \frac{\pi m}{9B}} \quad \ldots(5)$$

2. **Time period—**The total time taken by the charge particle to cross both the dees,

$$T = 2t \quad \ldots(6)$$

Using Eqn (5)

$$\boxed{T = \frac{2\pi m}{9B}} \quad \ldots(7)$$

Eqn (7) is the general expression for time period of cyclotron.

3. **Cyclotron frequency (v)—**

The recipyocal of time period is called cyclotron's frequency (ν). It is represented by (ν).

Using Eqn (7)

$$= \nu = \frac{1}{T} \quad \ldots(8)$$

Using in Eqn (7)

$$\boxed{\nu = \frac{9B}{2\pi m}} \quad \ldots(9)$$

Eq^n (9) is the general Eq^n for cyclotron's frequency

4. Cyclotron's singal frequency—

It can be defined as,

$$W = \frac{2\pi}{T} \quad \ldots(10)$$

$$W = e_\pi \times \frac{1}{T} \quad \ldots(11)$$

$$W = 2\pi\nu \quad \ldots(12)$$

Using Eq^n (9)

$$= W = 2\pi \times \frac{9B}{2\pi m}$$

$$= \boxed{W = \frac{9B}{m}} \quad \ldots(13)$$

5. Total energy acquired by charge particle—Since charge particle in motion, therefore it possess only kinetic energy.

$$E = K \cdot E = \frac{1}{2}mv^2 \quad \ldots(14)$$

Using in Eq^n (4)

$$= E = \frac{1}{2}m\left(\frac{9Br}{m}\right)^2$$

$$= E = \frac{1}{2}m\frac{9^2B^2r^2}{m^2}$$

$$= \boxed{E = \frac{9^2B^2r^2}{2m^2}} \quad \ldots(15)$$

For Max^m energy of charged particle radius must be Max^m.

$$\boxed{E_{max} = \frac{1}{2}\frac{9^2B^2r^2{}_{max}}{m}} \quad \ldots(16)$$

Hence, energy of particle is maximum of pheriphery.

Limitation of cyclotron—

1. Cyclotron cannot accelerate uncharged particle such as Neutron.
2. Cyclotron cannot accelerate negative charge particle suchas Electron.
3. Cyclotron cannot accelerate positive charge particle having larger mass.

13. Define Potentiometer. With the help of potentiometer compare the e.m.fs of two cells and measure internal resistance of the cell ?

Ans.—Potentiometer—Potentiometer is a device which is used to compare the emf of two cells and its used to mearsure the internal resistance of the cell.

Principle—

(i) Potentiometer wire should be of uniform area of cross-section.

(ii) Electric current passed through the wire must be constant.

Theory— Using Ohm's law.

V = 1R …(1)

But, $R = \int \frac{l}{A}$ …(2)

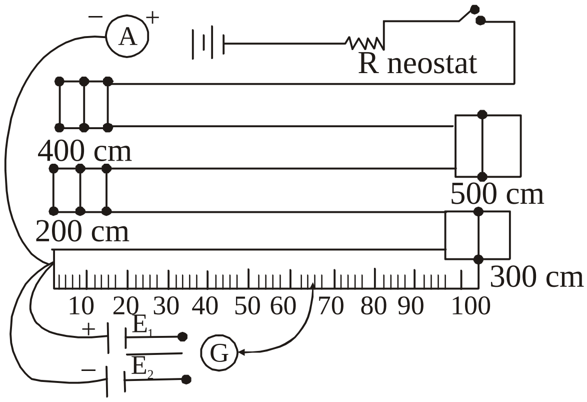
$\therefore \quad V = \frac{I\int l}{A}$ …(3)

∴ ρ, I and A is constant

∴ $V \propto l$ …(4)

The potential difference between two terminals of the wire is directly proportional to the length of the wire.

1. Compare the emf of two cell—



Working—

Potertiometer of wire of length 5 metre is attached with the scale Galvanometer. Then it is called balanced point. If one way key (k) is connected with cell of e.m.f. E_1 jockey is working. Its balanced point is G.

If one way (k_2) is connected with cell of e.m.f. E_0 jockey 'J' is working. Its balanced point is Driver's battery E is used to determine the balanced point.

Rneostat is a variable resistance.

According to the theory of potentiometer

for first cell.

$\in_1 \propto l_1$ …(5)

∴ $\in_1 = kl_1$ …(6)

For second cell

$\in 2 \propto l_2$ …(7)

$\in_2 = kl_2$ …(8)

According equation (6) by (7)

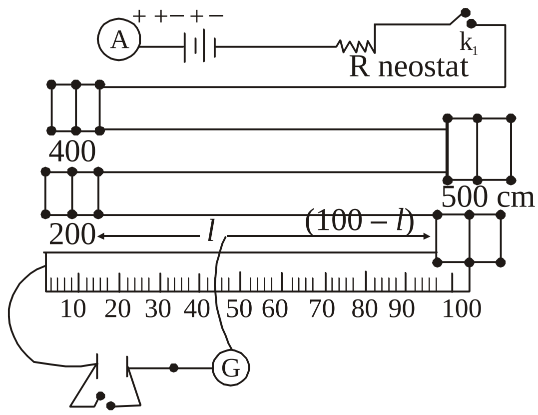
$$\frac{\in_1}{\in_2} = \frac{kl_1}{kl_2}$$

$$\frac{\in_1}{\in_2} = \frac{l_1}{l_2}$$ …(9)

Conclusion—

By knowing the length for null deflection or balanced points, E.m.f. of two cells can be easily compared.

II. To measure the internal resistance of the cell—



Working—Potentiometer of wire 5 metre is attached with the scale. Driver's battery is used to determine the balanced point or null deflection. If k_2 is open Emf of the cell can be measured. In case of E.m.f jockey I is working its balance point is l.

If k_2 is closed terminal voltage of the cell is applied its null deflection or balanced point is lo. In case of close key (k_2) jockey 'J' is working.

Expression

According to the theory of potentiometer

for open circuit.

$\in \propto l_1$ …(5)

$\in \propto k\, l_1$ …(6)

for closed circuit

$v \propto l_2$ …(7)

$v \propto k\, l_2$ …(8)

Dividing equating (6) by (8)

$$\frac{\in}{v} = \frac{kl_1}{kl_2}$$

$$\frac{\in}{v} = \frac{l_1}{l_2} \ldots(9)$$

By defination of E.m.f.

$\in = V + 1R$ …(10)

Dividing equation (10) by V

$$\frac{\in}{v} = \frac{v}{v} + \frac{I}{V}$$

$$\frac{\in}{v} = 1 + \frac{r}{R}$$

$$\frac{r}{R} = \left(\frac{\in}{R} - 1\right) \quad \ldots(11)$$

$$r = \left(\frac{\in}{R} - 1\right)R \quad \ldots(12)$$

Where

$$\frac{r}{R} = \frac{\text{Internal resistance}}{\text{External resistance}}$$

By equation (9)

$$r = \left(\frac{l_1}{l_2} - 1\right)R$$

Hence, by knowing the length of balanced point internal resistance of a cell can be easily determine with the help of potentiometer.

14. Explain p-n junction diode as a full wave rectifier ?

Ans.—Junction Diode as a full wave rectifier—Full wave rectifier rectifies both halves of a.c. input signal.

The circuit diagram of full wave rectifier as show in figure 16.

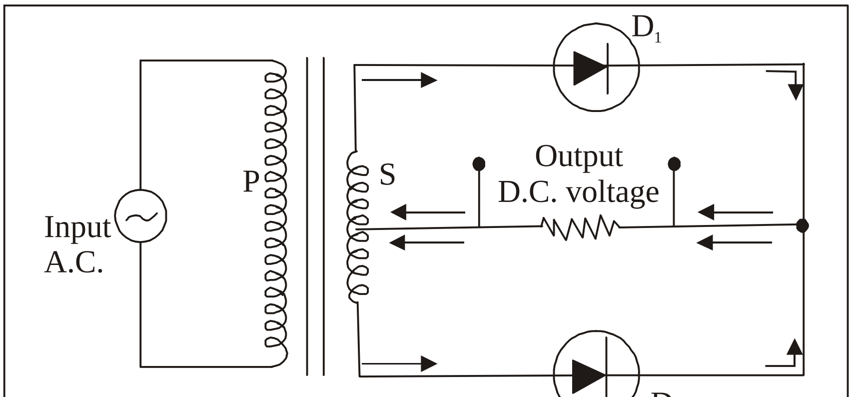
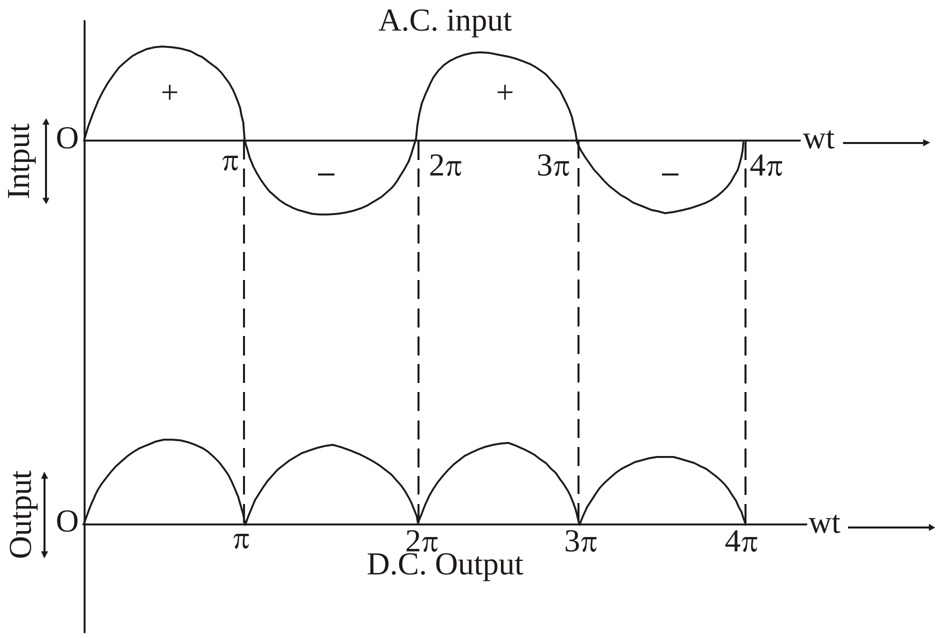


Figure 16

The a.c. input signal is fed to the primary (p) coil of the transformer. The p-regions of both the diodes D_1 and D_2 are connected to the two ends of the secondary coil (s). The load resistance R_1 across which output voltage is obtained is connected between common point of n regions of diodes and central tapping of the secondary coil.

Working—When positive half cycle of input a.c. signal flows through the primary coil, induced e.m.f. is set up in the secondary coil due to mutual induction. The direction of induced e.m.f. is such that the upper end of the secondary coil becomes positive while the lower end becomes negative. Thus, D_1 is forward biased and diode D_2 is reverse biased, So the current due to diode D_1 flows throught the output voltage which varies in accordance with the input half cycle is obtained accross the load resistance (R_1).

During negative half cycle of input a.c. signal, diode D_1 is reverse biased and diode D_2 is forward biased. The current due to diode D_2 flows through the circuit in a direction shown by arrows (below R_1). The output voltage is obtained across the load resistance (R_1).



15. For virtual image, prove the relation

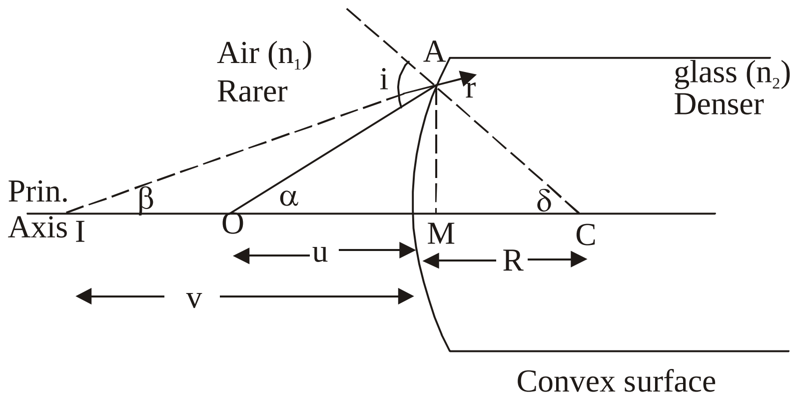
$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

Ans.—Refraction through convex surface—Virtual image Assumption—

(1) The spherical surface must be very-very thin.

(2) The object must lie on the principle axis and object is a point object.

(3) The angle made by object, image and normal must be very-very small.



In ΔOAC

$i = \alpha + \delta$ ...(1)

For smaller angle,

$$\left.\begin{array}{l}\alpha \simeq \tan\alpha \\ \delta \simeq \tan\delta\end{array}\right] \quad ...(2)$$

$\therefore$ $i = \tan\alpha + \tan\delta$ ...(3)

In ΔOAM

$$\tan\alpha = \frac{AM}{MO} \quad ...(4)$$

But, MO = PO ...(5)

$$\therefore \quad \tan\alpha = \frac{AM}{PO} \quad ...(6)$$

In ΔACM

$$\tan\alpha = \frac{AM}{MC} \quad ...(7)$$

But, MC = PC ...(8)

$$\therefore \quad \tan\alpha = \frac{AM}{PC} \quad ...(9)$$

Using in eq^n (3)

$$\therefore \quad \boxed{i = \left(\frac{AM}{PO} + \frac{AM}{PC}\right)} \quad ...(10)$$

In ΔIAC

$r = \beta + \delta$ ...(11)

For smaller angle,

$$\left.\begin{array}{l}\alpha \simeq \tan\beta \\ \delta \simeq \tan\delta\end{array}\right] \quad ...(12)$$

$\therefore$ $r = \tan\beta + \tan\delta$ ...(13)

In ΔIAM

$$\tan\beta = \frac{AM}{MI} \quad \ldots(14)$$

But MI = PI ...(15)

$$\therefore \quad \tan\beta = \frac{AM}{PI}$$

Using in eq^n (13)

$$\boxed{r = \left(\frac{AM}{PI} + \frac{AM}{PC}\right)} \quad \ldots(17)$$

Using Snell's law

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} \quad \ldots(18)$$

For smaller angle,

$$\left.\begin{array}{l}\sin i \simeq i \\ \sin r \simeq r\end{array}\right] \quad \ldots(19)$$

$$\therefore \quad \frac{i}{r} = \frac{n_2}{n_1}$$

$n_1 i = n_2 r$ ...(20)

Using eqn (10) + (17)

$$n_1\left(\frac{AM}{PO} + \frac{AM}{PC}\right) = n_2\left(\frac{AM}{PI} + \frac{AM}{PC}\right)$$

$$n_1\left(\frac{1}{PO} + \frac{1}{PC}\right) = n_2\left(\frac{1}{PI} + \frac{1}{PC}\right)$$

$$\frac{n_1}{PO} + \frac{n_1}{PC} = \frac{n_2}{PI} + \frac{n_2}{PC}$$

$$\frac{-n_2}{PI} + \frac{n_1}{PO} = \frac{n_2}{PC} + \frac{n_1}{PC}$$

$$\frac{-n_2}{PI} + \frac{n_1}{PO} = \frac{n_2 - n_1}{PC} \quad \ldots(21)$$

Using proper sign-convention,

$$\left.\begin{array}{l}PI = -v \\ PO = -u \\ PC = R\end{array}\right] \quad \ldots(22)$$

$$\therefore \quad \boxed{\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}} \quad \ldots(23)$$