PHYSICS

PAPER & SOLUTION

Code : SS-40-1-PHY

Time : 3 ¼ Hours **M.M. 56**

General Instruction :

(1) Candidates must write first his/her Roll Nos. on the questions paper compulsorily.
(2) All the questions are compulsory.
(3) Write the answer to each question in the given answer-book only.
(4) For questions having more than one part, the answers to those parts are to be written together in continuity.
(5) If there is any error/difference/contradiction in Hindi and English versions of the question paper, the question of Hindi version should be treated valid.
(6)

Q. Nos.	Marks Per question
1 – 13	1
14 – 24	2
25 – 27	3
28 – 30	4

(7) There are internal choices in Q. nos. 21 & 27 to 30.
(8) Use of calculator is not allowed in the examination.

Q.1 Write the name of physical quantity whose unit is J/C. State whether this quantity is a vector o scalar? **[1]**

Sol. The physical quantity whose S.I. unit is J/C is electric potential. It is a scalar quantity.

Q.2 Define Super Conductivity. **[1]**

Sol. Super conductivity is a phenomenon of exactly zero electrical resistance in superconductors when cooled below a critical temperature.

Q.3 Write the definition of figure of merit of Galvanometer. **[1]**

Sol. It is defined as the current which produces a deflection of one scale division in the galvanometer and is given by

$$G = \frac{I}{\theta} = \frac{K}{N \cdot BA}$$

K = Torsion constant

θ = deflection angle

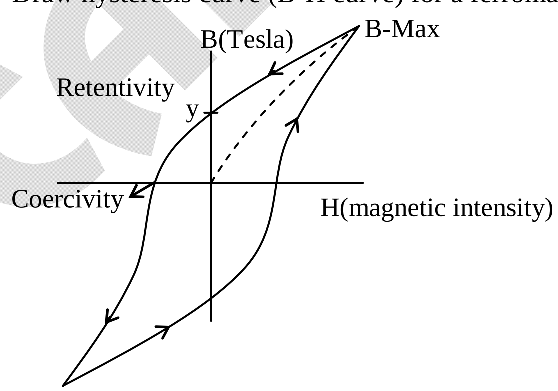
N = Total no. of turns in coil

B = Magnetic field

A = Area of coil.

Q.4 Draw hysteresis curve (B-H curve) for a ferromagnetic substance. **[1]**

Sol.



Hysterisis curve for Ferromagnetic substance

* Ferromagnetic materials has high retentivity & low coercivity.

Q.5 Find the time taken by alternating current to attain zero from peak value. The frequency of alternating current is 50Hz. **[1]**

Sol. In AC

$f = \frac{1}{T}$

$T = \frac{1}{f} = \frac{1}{50}$

T = 0.02 sec

Time taken by alternating current to attain zero from peak is $\frac{T}{4} = \frac{0.02}{4} = 0.005$ sec.

Q.6 Write Malus law. **[1]**

Sol. Malus Law : When a beam of completely plane polarized light is passed through analyzer, the intensity 'I' of transmitted light varies directly as the square of the cosine of the angle 'θ' between the transmission directions of polarizer & analyzer. This statement is know as law of malus

Mathematically

$I \propto \cos^2\theta$

$I = I_0\cos^2\theta$

Q.7 What does mean by work function for metals? **[1]**

Sol. Work function (ϕ) : The minimum energy required to emit the electron from metal surface is known as work function. Unit of work function is joule & electron volt

Q.8 Find the de-Broglie wave length related to an electron accelerated by 10^4 volt. **[1]**

Sol. The wavelength associated with electron

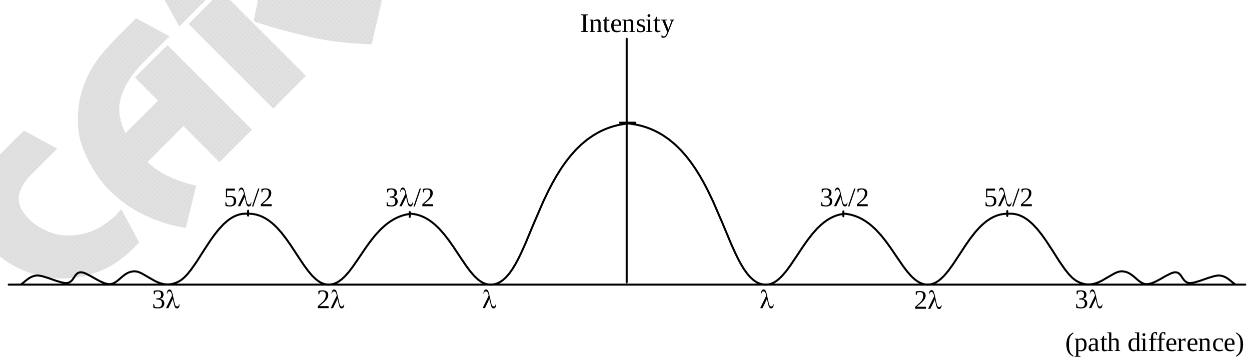
$\lambda = \frac{12.3}{\sqrt{V}}$ Å; $\lambda = \frac{12.3}{\sqrt{10^4}}$ Å; $\lambda = \frac{12.3}{10^2} = .123$Å

Q.9 Write he name of any one dopped semiconductor used for making light emitting diode(LED). **[1]**

Sol. The compound semi-conductor helium –Arsenide – Phosphide (ha $As_{0.6} – P_{0.4}$) used for making LED lights.

Q.10 Draw the curve for intensity distribution in diffraction by single slit. **[1]**

Sol.

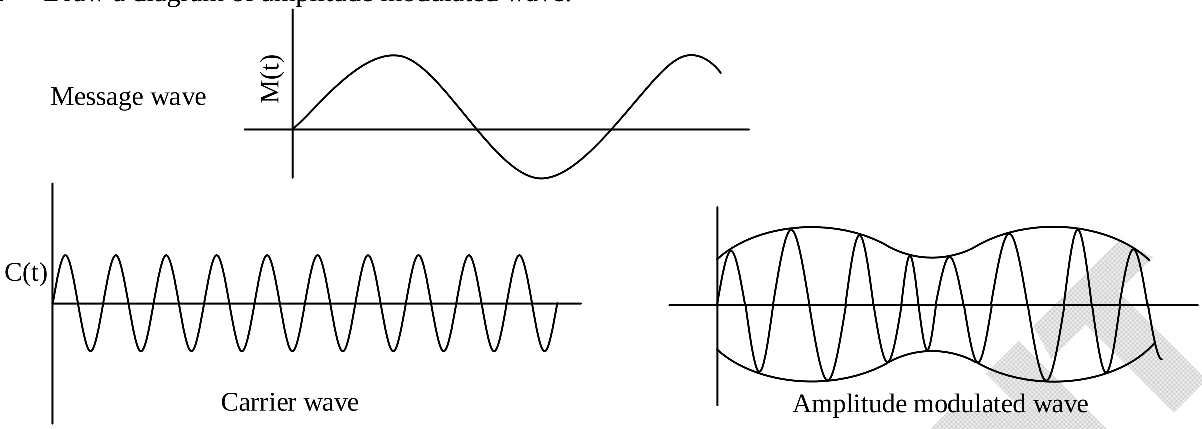


Q.11 What will be the value of neutron multiplication factor for controlled chain reactions? **[1]**

Sol. The value of neutron multiplication factor in controlled chain reaction should be k = 1.

Q.12 Draw a diagram of amplitude modulated wave. **[1]**

Sol.



Q.13 Write any two Maxwell's equations. **[1]**

Sol. Maxwell equation

1) Gauss law of electrostatics : This law states that the electric flux through a closed surface S is $\frac{1}{\epsilon_0}$ times the total change q enclosed by the surface S.

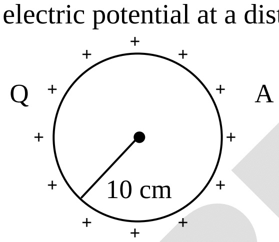
$$\oint \vec{E} \cdot \vec{dS} = \frac{q}{\epsilon_0}$$

2) Modified Ampere's law : This law states that the line integral of the magnetic field around any closed circuit C is equal to μ_0 times the total current (sum of conduction & displacement currents) threading the closed circuit.

$$\oint \vec{B} \cdot \vec{d\ell} = \mu_0[\sum I_c + \sum Id] = \mu_0[\sum I_c + \epsilon_0 \frac{d\phi}{dt}]$$

Q.14 Electric Potential on the surface of a charged spherical shell of radius 10cm is 50volt. Find the value of electric potential at a distance of 20cm from the centre of spherical shell. **[2]**

Sol.



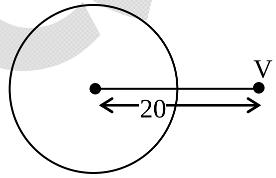
Potential at surface = 50 V

$V = \frac{K \cdot Q}{R}$

$50 = \frac{K \cdot Q}{0 \cdot 1}$

KQ = 5

Potential at 200 m from centre



$V = \frac{K \cdot Q}{r}$

$V = \frac{5}{0.2} = 25$ volt

Q.15 The Resistance of a conductor is XΩ at 0ºC temp. Find the temperature at which the resistance of conductor becomes 3XΩ. The temp. Coefficient of resistance for conductor is 0.4×10^{-2} ºC^{-1} which is constant. **[2]**

Sol. Formula

$R_2 = R_1[1 + \alpha(T_2 - T_1)]$

$R_1 \rightarrow$ Resistance at T_1

$R_2 \rightarrow$ Resistance at T_2

$\alpha \rightarrow$ Temperature coefficient

$R_1 = x$

$R_2 = 3x$

$T_1 = 0^o$

$T_2 = ?$

$\alpha = 0.4 \times 10^{-2}$

$3x = x(1 + 0.4 \times 10^{-2}(T_2 - 0))$

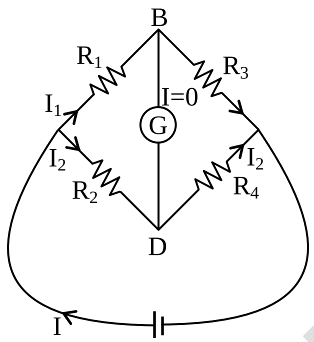
$3 = 1 + 0.4 \times 10^{-2} (T_2)$

$2 = 0.4 \times 10^{-2}\ T_2$

$$T_2 = \frac{2}{0.4\times10^{-2}} = \frac{2\times10^3}{4} = 500^oC.$$

Q.16 Obtain necessary condition for balancing state of Wheat Stone Bridge by using Kirchoff's law. Draw necessary circuit diagram. **[2]**

Sol.



I = 0 in galvanometer branch

Applying Kirchoff's law for loop ABCD A

$-I_1R_1 + 0 + I_2R_2 = 0$

$I_1R_1 = I_2R_2$

$$\frac{I_1}{I_2} = \frac{R_2}{R_1} \quad \ldots(1)$$

Applying Kirchoff's law for loop BCDB

$-R_3I_1 + I_2R_4 + 0 = 0$

$I_1R_3 = I_2R_4$

$$\frac{I_1}{I_2} = \frac{R_4}{R_3} \quad \ldots(2)$$

From equal (1) & (2)

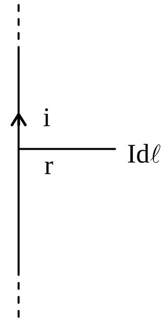
$$\frac{I_1}{I_2} = \frac{R_2}{R_1} = \frac{R_4}{R_3}$$

$$\frac{R_2}{R_1} = \frac{R_4}{R_3}$$

$\boxed{\frac{R_1}{R_2} = \frac{R_3}{R_4}}$ Balancing condition for wheat stone bridge

Q.17 Obtain an expression for magnetic field due to infinitely long straight current carrying conductor by using Amperes law. **[2]**

Sol.



Ampere's law equation

$$\oint \vec{B}\cdot\vec{d\ell} = \mu_0\Sigma i$$

Here $\vec{d\ell}$ length element perpendicular to the plane of paper.

$$\oint \vec{B}\cdot\vec{d\ell} = \mu_0\Sigma i$$

B → magnetic field which is also perpendicular to plane of paper & align with length element.

$$\oint \vec{B}\cdot\vec{d\ell} = \mu_0\Sigma i$$

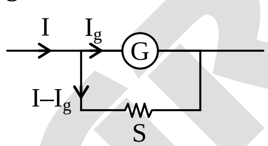
$$B\cdot\oint d\ell = \mu_0 i$$

$$B\cdot 2\pi r = \mu_0 i$$

$$\boxed{B = \frac{\mu_0 i}{2\pi r}}$$

Q.18 The resistance of a galvanometer is 99Ω. The necessary current for full scale deflection is 1 mA. If a shunt of 1Ω is connected with galvanometer then find the value of maximum current which can be measured by this galvanometer. **[2]**

Sol.



$$I_g\cdot G = (I-I_g)\cdot S$$

$$I - I_g = \frac{I_g\cdot G}{S}$$

$$I = \frac{I_g\cdot r}{S} + I_g$$

$$I = \frac{10^{-3}\times 99}{1} + 10^{-3}$$

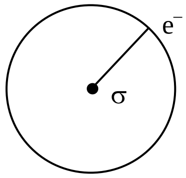
$$I = 100 \times 10^{-3} = 0.1 \text{ Ampere}$$

Q.19 (a) Write definition of Curie temperature for ferromagnetic substances. **[2]**

(b) Obtain an expression for magnetic moment of an orbital electron.

Sol. (a) The temperature at which a ferromagnetic substance becomes paramagnetic is called curie temperature or curie point T_C.

Cause : When ferromagnetic sample heated, its magnetisation decreases due to the increase in the randomisation of its domains. At high temperature, the domain structure disintegrates & the ferromagnetic substance becomes paramagnetic.

(b) 

$I = \frac{e}{T}$

$V = \frac{2\pi r}{T}$

$T = \frac{2\pi r}{V}$

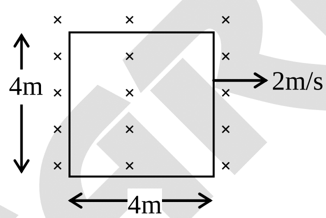
$I = \frac{e}{\frac{2\pi r}{V}} = \frac{eV}{2\pi r}$

Magnetic moment (μ) = I A

$\vec{\mu} = \frac{eV}{2\pi r} \times \pi r^2$

$\mu = \frac{eVr}{2}$

Q.20 The length of side of a square loop is 4m. This loop is placed in a uniform magnetic field of 2.5 t. Outside the loop, the magnetic field is zero and it is coming out side from magnetic field perpendicularly with velocity 2m/s. Find the value of induced emf in loop after one second. **[2]**

Sol. 

B = 2.5T

$\phi_1 = 2.5 \times 4 \times 4$ (initial flux)

$\phi_1 = \frac{25}{10} \times 16 = 40$ (weber)

$\phi_2 = 2.5 \times 4 \times 2$ weber (after 1 sec. flux)

$\Delta\phi = \phi_2 - \phi_1$ (Change in flux)

$\Delta\phi = 20 - 40 = -20$

$\varepsilon = -\frac{\Delta\phi}{\Delta t}$; $\varepsilon = -\frac{(-20)}{1\,sec}$; $\varepsilon = 20$ volt

Q.21 Find the ratio of maximum wavelength of minimum wavelength for the lines of Balmer series in hydrogen spectrum. **[2]**

OR

In a radioactive sample the numbers of active nuclei remains 6.25% of its initial value in 6hr. Find the half life of radioactive sample.

Sol. For Balmer

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$$

$$\frac{1}{\lambda_{max}} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda_{min}} = R\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)$$

$$\frac{\frac{1}{\lambda_{max}}}{\frac{1}{\lambda_{min}}} = \frac{\left(\frac{1}{4} - \frac{1}{9}\right)}{\left(\frac{1}{4}\right)}$$

$$\frac{\frac{1}{\lambda_{max}}}{\frac{1}{\lambda_{min}}} = \frac{\frac{5}{36}}{\frac{1}{4}}$$

$$\frac{\lambda_{min}}{\lambda_{max}} = \frac{5}{36} \times \frac{4}{1} = \frac{5}{9}$$

$$\frac{\lambda_{max}}{\lambda_{min}} = \frac{9}{5}$$

OR

$$N = N_0 e^{-\lambda t}$$

$$\log \frac{N}{N_0} = -\lambda t$$

$$\log \frac{N_0}{N} = \lambda t$$

$$\frac{1}{t} \log \frac{N_0}{N} = \lambda$$

$$\frac{1}{t} \log \frac{100}{6.25} = \lambda$$

$$T_{1/2} = \frac{\log 2}{\lambda}$$

$$T_{1/2} = \frac{\log 2}{\frac{1}{6} \log 2^4} = \frac{\log 2}{\frac{4}{6} \log 2}$$

$$T_{1/2} = \frac{6}{4} = \frac{3}{2} = 1.5$$

Q.22 Derive Einstein's Photoelectric equation. Explain photoelectric effect with help of this equation. **[2]**

Sol. Einstein's Photoelectric equation :

By conservation of energy

Energy of incident photon = maximum K·E of e^- + work function

$$h\nu = \frac{1}{2} mV_{max}^2 + W_0$$

$$(W_0 = \frac{h\nu_0}{\text{Threshold frequency}})$$

$$K_{max} = h\nu - h\nu_0$$

$$K_{max} = h(\nu - \nu_0)$$

(1) Explanation of effect of intensity : The increase of intensity means the increase the number of photons striking the metal surface at unit time. As each photon ejects only one e^- so the number of ejected electron increases.

(2) Explanation of threshold frequency : If $\nu \propto \nu_0$ that is the frequency of incident radiation is less than the threshold frequency, the kinetic energy of photoelectrons becomes negative. This is no physical meaning.

(3) Explanation of kinetic energy : If $\nu > \nu_0$ then the maximum kinetic energy of e^- increases linearly with frequency ν.

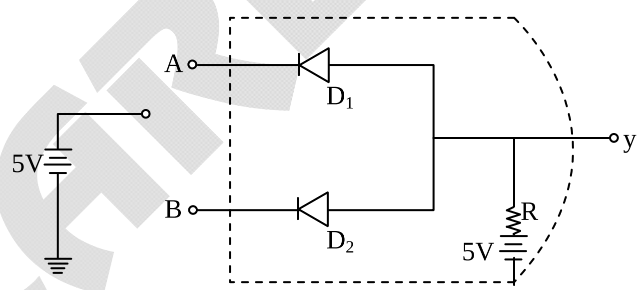
(4) Explanation of time lag : Photoelectric emission is the result of elastic collision b/w photon & e^-. The transfer of energy of photon to e^- is one lump not continuous absorption.

Q.23 a) What are logic gates? **[2]**

b) Draw a circuit diagram for dual-input AND Gate by using two diodes.

Sol. (a) logic gates : A gate is a digital circuit that is designed for performing a particular logical operation. As it work according to some logical relationship b/w input & output voltages, so it is generally known as a logic gates.

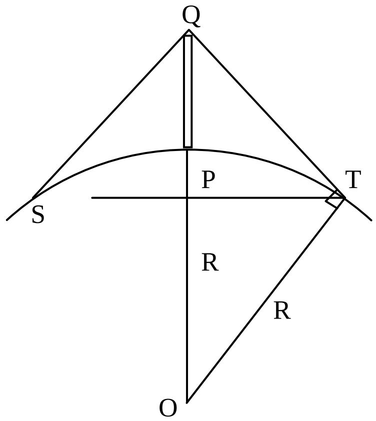
(b)



Circuit diagram of AND gate by using two diodes.

Q.24 Establish a relation between maximum distance of broadcast and height of antenna in space wave propagation. **[2]**

Sol.



PQ = h_T (height of antenna)

PS = PT = d

From right angled ΔOTQ, we get

$OQ^2 = OT^2 + QT^2$

Here OQ = R + h_T

QT = PT = d

OT = R = Radius of earth

$(R + h_T)^2 = R^2 + d^2$

$R^2 + h_T^2 + 2Rh_T = R^2 + d^2$

$d^2 = h_T^2 + 2Rh_T$

$d^2 = 2Rh_T\left[1 + \frac{h_T}{2R}\right]$

$\frac{h_T}{2R} << 1$

$d^2 = 2h_TR$

$d = \sqrt{2h_TR}$

the maximum distance d_M, between Transmitting & receiving antennas is given by

$d_M = d_T + d_R$

$d = \sqrt{2Rh_T} + \sqrt{2Rh_R}$

d_T = horizon for transmitting antenna

d_R = horizon for receiving antenna

h_T = height of transmitter

h_R = height of receiver

d = maximum distance of broadcast

Q.25 a) What does mean by magnifying power of a Microscope? **[3]**

b) An object is placed at 20 cm from a convex lens. If 3 times magnified real image is formed by the lens then find the focal length of lens.

Sol. (a) Magnifying Power : The magnifying power of a simple microscope is defined as the ratio of the angles subtended by the image & the object at the eye, when both are at the least distance of distinct vision from the eye.

Magnifying power = $\dfrac{\text{Angle subtended by the image at the least distance of distinct vision}}{\text{Angle subtended by the object at the least distance of distinct vision}}$

(b) $m = \dfrac{f}{f+4}$ For real image $m = -3;\ u = -20$

$-3 = \dfrac{f}{f-20}$

$-3f + 60 = f$

$4f = 60$

$f = 15$ cm

Q.26 What does mean by mass defect? Establish relation between mass defect and nuclear binding energy. And hence write the expression for binding energy per nucleon. **[3]**

Sol. **Mass defect :** It is found that mass of a stable nucleus is always less than the sum of masses of its constituent protons and neutrons in their free state.

Consider the Nucleus ${}^{A}_{Z}X$. It has Z protons and (A – Z) neutrons, therefore, its mass defect will be

$\Delta m = Zm_p + (A - Z)\, m_n - m$

Expression for binding energy : The nucleus ${}^{A}_{Z}X$ contains Z protons and (A – Z) neutrons.

Its mass defect is

$\Delta m = Zm_p + (A - Z)m_n - m_N$

Where $m_N \rightarrow$ mass of nucleus

$\Delta E_b = \Delta m \times c^2 = [Zm_p + (A - Z)m_n - m_N]c^2$

Mass defect always improve binding energy of nucleus. More mass defect is more stable nucleus.

Q.27 Draw circuit diagram for a P-N junction to obtain reverse bias characteristic curves. Explain the phenomenon of reverse breakdown for a P-N junction in reverse bias state by following processes –

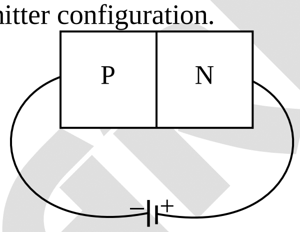
i) Avalanche breakdown

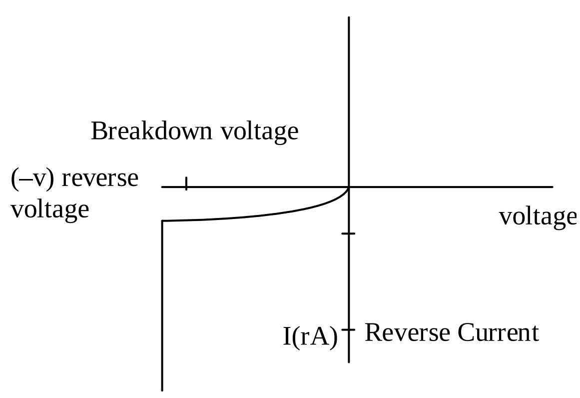
ii) Zener breakdown

OR

Draw circuit diagram for a NPN-transistor to obtain characteristic curves in common base configuration. Establish a relation between current amplification factors for a transistor in common base and common emitter configuration. **[3]**

Sol.



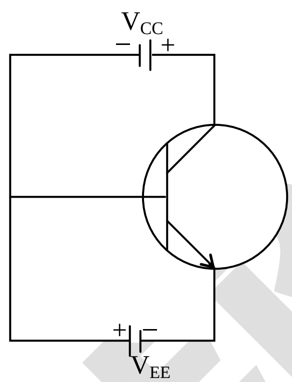


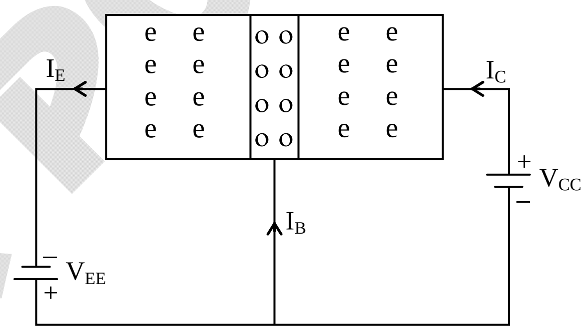
When we connect P–N junction diode in reverse condition the minority from both side of P–N diode move hence the reverse current flow.
When we increase the reverse voltage the depletion layer breaks at certain reverse voltage this voltage is known as break down voltage.
The break down of depletion layer can be two type.

(1) Avalanche breakdown : the minority charge carrier get highly accelerated. The kinetic energy becomes high enough at they knock-off electrons from the covalent bonds of semiconductors. The newly generated electron holes pairs also accelerated and cause ionisation the depletion layer & break down the depletion layer.

(2) Zener breakdown : Due to high doping in zener diode the depletion layer has small width. When large reverse biased applied across such a diode, the depletion layer & the energy bands get modified, As the depletion width is very small, small voltage will set high electric field of 4×10^7 V/m. this high electric field strips off many electrons from valence band which tunnel to the n-side through the this depletion layer. It gives rise to a large reverse current or breakdown current this breakdown in a diode due to the band to band tunneling is called zener breakdown.

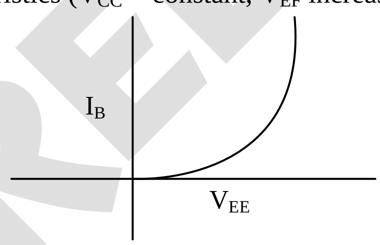
OR



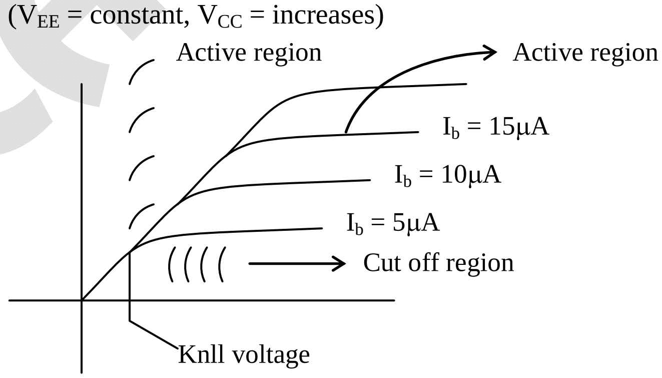


CEC

(a) Input characteristics (V_{CC} = constant, V_{EF} increases)



(b) Output Characteristics :
(V_{EE} = constant, V_{CC} = increases)



(2) Current amplification (β) = $\frac{I_C}{I_B}$ (CE configuration)

Current amplification (α) = $\frac{I_C}{I_E}$ (CB configuration)

$$\alpha = \frac{I_C}{I_E}$$

$$\alpha = \frac{\frac{I_C}{I_B}}{\frac{I_E}{I_B}}$$

$$\alpha = \frac{\beta}{\frac{I_B + I_C}{I_B}}$$

$$\alpha = \frac{\beta}{1+\beta}$$

$$\boxed{\alpha = \frac{\beta}{1+\beta}}$$

Q.28 Write definition of electric field intensity.
Obtain an expression for electric force and electric pressure on the surface of a charged conductor.
Draw necessary diagram.

OR

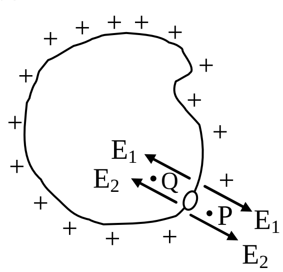
What does mean by energy stored in capacitor?
Prove that –
"The ratio of change in potentials of conductors after connecting two charged conductors is inversely proportional to their capacitances".
Draw a curve between electric field and distance for an uniformly for an uniformly charged non-conducting sphere. **[4]**

Sol. **Electric field intensity :** It is the strength of an electric field at any point. It is equal to the electric force per unit charge experienced by a test charge placed at that point. The unit of it is volt/meter or Newton/Coulomb.

Every element of a charged conductor experience a normal outward mechanical force. This is the result of repulsive force from similar changes present on the rest of the surface of the conductor.

Consider a small element ds on the surface of a charge conductor. if σ is the surface charge density and the charge carried by the element ds be dq.

$dq = \sigma.ds$ ....(i)



Consider a point P just outside the surface near the element ds. The electric intensity at a point P is given by

$$E = \frac{\sigma}{\epsilon_0} \qquad \text{....(ii)}$$

The direction of the intensity is normally outwards.

The intensity made up of two components $\vec{E}_1$ due to the small change dq present on the element ds.

$\vec{E}_2$ due to the remaining charge present on the rest of the surface of the conductor.

Hence at P, $\vec{E}_1 + \vec{E}_2 = \frac{\sigma}{\epsilon_0}$

* Now consider a point Q inside the conductor the electric field E_1 and E_2 at this point are oppositely directed. However, electric intensity inside a changed conductor is zero

$$\vec{E}_1 - \vec{E}_2 = 0$$

$$\vec{E}_1 = \vec{E}_2$$

Substituting for $\vec{E}_1$ in eq.(3) we have

$$2E_2 = \frac{\sigma}{\epsilon_0}; E_2 = \frac{\sigma}{2\epsilon_0}$$

* Here E_2 is the electric field due to the charge on the rest of conductor. Hence repulsive force experienced by element ds carrying charge dq due to is given by

$$\vec{F} = \vec{E}_2.dq$$

$$F = \frac{\sigma}{2\epsilon_0}dq$$

$$F = \frac{\sigma}{2\epsilon_0}.\sigma.dq$$

$$F = \frac{\sigma^2}{2\epsilon_0}.dq$$

The electric pressure on surface ds will be

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = \frac{\frac{\sigma^2}{2\epsilon_0}.ds}{ds}$$

$$P = \frac{\sigma^2}{2\epsilon_0}\ \text{N/m}^2$$

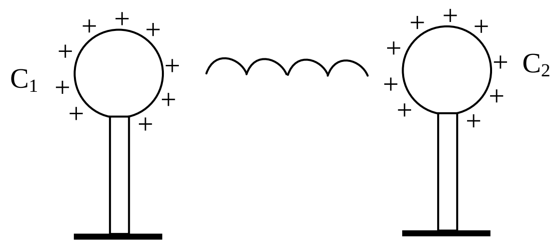
OR

Energy stored in a capacitor : A capacitor is a device to store energy. The process of charging up a capacitor involves the transferring of electric charges from its one plate to another.

The work done in charging the capacitor is stored as its electrical potential energy.

Consider two insulated conductor A and B of capacitances C_1 and C_2 and carrying charges Q_1 and Q_2. Let V_1 and V_2 be their respective potentials.

$$Q_1 = C_1V_2 \text{ and } Q_2 = C_2V_2$$



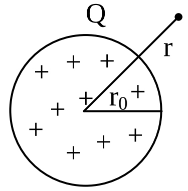
If connect with wire charge flow form higher to lower potential.
Total charge on system $Q_1 + Q_2$
Total capacitance $C_1 + C_2$

$$V = \frac{Q}{C} = \frac{Q_1 + Q_2}{C_1 + C_2} = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

$$\boxed{V \propto \frac{1}{C_1 + C_2}}$$

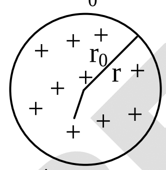
Electric field distance curve by uniformly charged non-conducting sphere.
E outside $(r > r_0)$

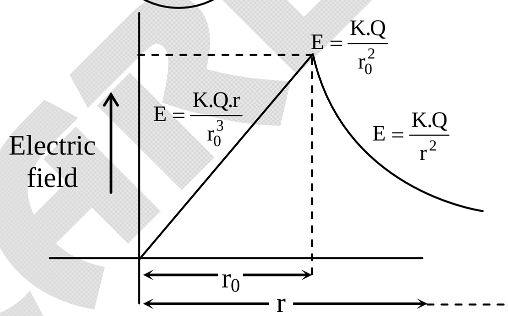
$$E = \frac{KQ}{r^2}$$



E inside $(r < r_0)$

$$E = \frac{K.Q.r}{r_0^3}$$





Q.29 Write one merit and one de-merit of alternating current in comparison of direct current.
Obtain expression for following in a pure inductive alternating current circuit –

i) Instantaneous value of current

ii) Reactance of circuit

iii) Peak value of current

Draw curve for power in pure inductive circuit.

OR

What does meant by half power point frequencies.

Obtain an expression for bandwidth in a LCR series circuit.

Show half power point frequencies in curve between alternating current and frequency. **[4]**

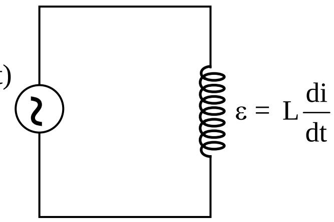
Sol. **Advantage**

The generation of AC is more economical than DC.

Disadvantage

Peak value of AC is high. It is dangerous to work with AC ($I_0 = \sqrt{2}\, I$).

Pure inductor



$$V_0\sin(\omega t) - L\frac{di}{dt} = 0$$

$$V_0\sin(\omega t) = L\frac{di}{dt}$$

$$\int \frac{V_0}{L}\sin(\omega t)\,dt = \int di$$

$$-\frac{V_0}{L\omega}[\cos(\omega t)] = i$$

$$-\frac{V_0}{X_L}\left[\sin\left(\frac{\pi}{2} - \omega t\right)\right] = i$$

$$-i_0 \sin\left(\frac{\pi}{2} - \omega t\right) = i$$

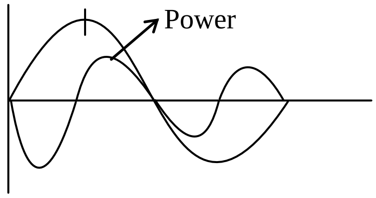
$$\boxed{i = i_0 \sin\left(\omega t - \frac{\pi}{2}\right)}$$

(i) $i_0 = \frac{V_0}{X_L} = \frac{V_0}{\omega L}$ → peak value of current

(ii) $X_L = \omega L$ → inductive reactance

(iii) $i = i_0 \sin\left(\omega t - \frac{\pi}{2}\right)$ instantaneous value

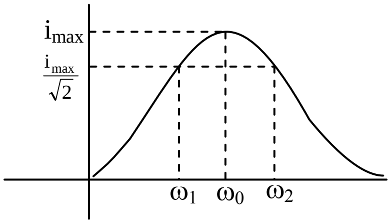
Power



OR

Half power point frequency : The input frequency at which the power dissipation in LCR circuit becomes half of maximum power.

Resonance condition :



Here

$\omega_1 = \omega_0 - \Delta\omega$

$\omega_2 = \omega_0 + \Delta\omega$

Band width

$\omega_2 - \omega_1 = (\omega_0 + \Delta\omega) - (\omega_0 - \Delta\omega)$

$\omega_2 - \omega_1 = 2\Delta\omega$

The ω_1 and ω_2 has frequency at which maximum current becomes $\frac{1}{\sqrt{2}}$ time of its value

$V_0 = I_0Z$

$$\frac{V_0}{Z} = \frac{I_0}{\sqrt{2}}$$

$$\frac{I_0R}{Z} = \frac{I_0}{\sqrt{2}} \qquad [V_0 = I_0R]$$

$$\sqrt{2}\,R = Z$$

$$\sqrt{2}\,R = \left(\sqrt{R^2 + (X_C - X_L)^2}\right)$$

$$2R^2 = R^2 + \left(\frac{1}{\omega C} - \omega L\right)$$

$$R^2 = \left(\frac{1}{\omega_1 C} - \omega_1 L\right)^2$$

$$R^2 = \frac{1}{(\omega_0 + \Delta\omega)C} - (\omega_0 + \Delta\omega)L$$

$$R = \frac{1}{\omega_0 C\left(1 + \frac{\Delta\omega}{\omega_0}\right)} - \omega_0 L\left(1 + \frac{\Delta\omega}{\omega_0}\right)$$

$$R = \omega_0 L\left(1 + \frac{\Delta\omega}{\omega_0}\right)^{-1} - \omega_0 L\left(1 + \frac{\Delta\omega}{\omega_0}\right)$$

$$R = \omega_0 L \left(1 - \frac{\Delta\omega}{\omega_0}\right) - \omega_0 L \left(1 + \frac{\Delta\omega}{\omega_0}\right)$$

$$R = \omega_0 L \left[1 - \frac{\Delta\omega}{\omega_0} - 1 - \frac{\Delta\omega}{\omega_0}\right]$$

$$R = \omega_0 L \left[\frac{2\Delta\omega}{\omega_0}\right]$$

$$R = L2\Delta\omega$$

$$\boxed{\Delta\omega = \frac{R}{2L}}$$ band width

Q.30 Write any two necessary conditions for interference of light. Obtain an expression for fringe width in Young's double slit experiment. Draw curve for intensity distribution in Young's double slit experiment.

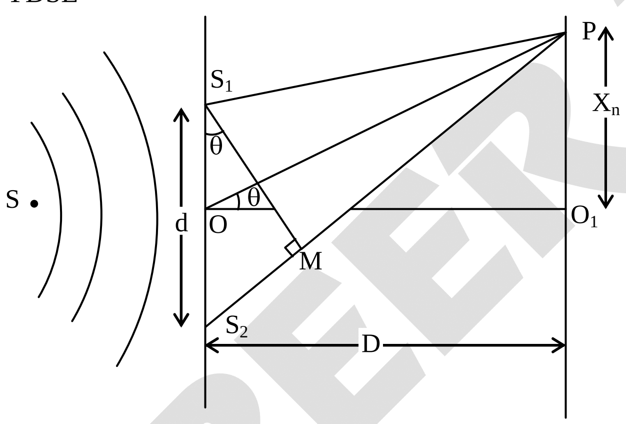
OR

Write definitions of plane of vibration and plane of polarization. Explain the working process to obtain plane polarized light by Nicole Prism. Draw necessary diagram. **[4]**

Sol. 1) Light should be propagate in same direction

2) Light should be coherent lights.

YDSE



ΔS_1S_2M

$$\sin\theta = \frac{S_2M}{d}$$

$$\theta = \frac{S_2M}{d}$$

ΔOO_1P

$$\tan\theta = \frac{X_n}{D}$$

$$\theta = \frac{X_n}{D}$$

$$\frac{S_2M}{d} = \frac{X_n}{D}$$

$$\boxed{S_2\,M = \frac{X_n}{D}\cdot d}$$

$$\frac{X_n}{D} = n\lambda$$

$$X_n = \frac{n_2 D}{d}$$

for dark fringe width (β_{dark})

$$\beta_{dark} = X_{n+1} - X_n$$

$$= X_{n+1} - X_n$$

$$= (n+1)\frac{\lambda D}{d} - \frac{n\lambda D}{d}$$

$$= \frac{\lambda D}{d}(n + 1 - n)$$

$$\boxed{\beta_{dark} = \frac{\lambda D}{d}}$$

For bright fringe width (β_{bright}) :

$$\frac{X_{nd}}{D} = (2n+1)\frac{\lambda}{2}$$

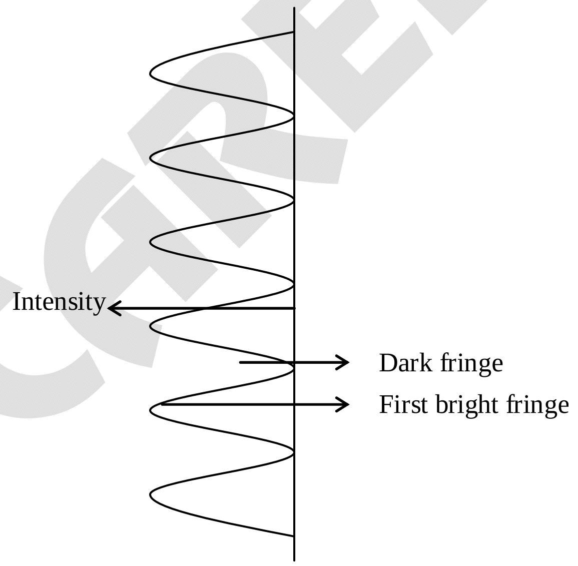
$$\beta_{Bright} = X_{n+1} - X_n$$

$$\beta_{Bright} = (2(n+1)+1)\frac{\lambda D}{2d} - (2n+1)\frac{\lambda D}{2d}$$

$$= \frac{\lambda D}{2d}(2n + 2 + 1 - 2n - 1)$$

$$= \frac{\lambda D}{2d}\cdot 2$$

$$\boxed{\beta_{Bright} = \frac{\lambda D}{d}}$$



OR

Plane of vibration : The plane in which the vibration of electric field and magnetic field vibrate it is always perpendicular plane with direction of propagation.

Plane of polarisation : The plane in which remaining vibration vibrate after the process of polarisation. It is also perpendicular plane to the direction of propagation of light.

POLARISATION BY NICOLE PRISM :-

Principle : When a thin film of canada balsam is placed between two calcite pieces, the O-rays of the unpolarised incident light get eliminated through the phenomenon of total internal reflection while E-rays are transmitted unaffected and emerge as a beam of plane polarised light.

Working : The principal section ACGE of a Nicole prism. The diagonal AG represents the canada balsam layer. When ray of unpolarised light passes from a portion of the calcite crystal into the layer of canada balsam, it passes from a denser to a rarer medium. When the angle of incidence is greater than the critical angle $(\simeq 69^o)$, the ray is totally reflected and absorbed by a blackened surface. The E-ray is not effected because it is travelling from rarer medium to denser medium. It gets transmitted through the Nicole prism. Hence a ray passes from Nicole prism get polarised.