Q→ 1 Explain the cölombs Law? Also
Part 2 State it with the help of expression?

Ans:- I Colomb's Law:- State that:
An isolated q induces an electric feild E at every point in space and at any specific point P, E is given by

$$E = R \frac{q}{4\pi\varepsilon R^2} \quad V/m$$

In the presence of electric feild E at the given point in space which may due to a single charge or a distribution of many charges

$$F = q = E \ (N)$$

With F measured in newtons (N) and q in coulombs (C) the unit of E is (N/C) which is same as volt per meter (V/m).

$$\vec{D} = \varepsilon \vec{E}$$

with:

$$\varepsilon = \varepsilon_r \varepsilon_0$$

where

$$\varepsilon_0 = 8.85 \times 10^{-12} \equiv (1/36\pi) \times 10^{-9}$$
(F/m)

Part (1) Write down the Maxwell's Equations
Maxwell expression comprise the

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Fundamental tenets of electromagnetic theory. Explain.

Ans:- I Maxwells equations: Describe how electric charges and electric current create electric and magnetic feild. The first equation allow you to calculate the electric feild create by a charge

Maxwell's Equation Differential form:-

$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \times \vec{E} = \frac{\partial \vec{B}}{\partial t}$$

$$\nabla \cdot \vec{B} = 0$$

$$\nabla \times \vec{B} = \mu_0 \vec{J}$$

Maxwell's Equation Integral form:-

$$\oint \vec{E} \cdot da = \frac{Q_{enc}}{\varepsilon_0}$$

$$\oint \vec{E} \cdot \vec{dl} = -\int \frac{\partial \vec{B}}{\partial t} \cdot \vec{da}$$

$$\oint \vec{B} \cdot \vec{da} = 0$$

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 \boxed{\mu_0 \varepsilon_0 \int \frac{\partial E}{\partial t}}$$

Maxwell's equation in electromagnetic theory:-

With the publication of "A Dynamical theory of the electromagnetic feild in 1865 Maxwell demonstrated that electric and magnetic feilds travel through space as waves moving at the speed of light. He proposed that light is an undulation in the same medium that is the cause of electric and magnetic phenomena.

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Part: (3) What is the difference between convection and conduction currents?

Ans:- An example of a convection current is a cloud bearing free electrons that moves through the atmosphere driven by wind

Conduction Current:- Consist of charged particles moving in response to the electric feild not marely being carried by motion of the surrounding material.

Part (4) State the principle of linear superposition as it applies to the electric feild distribution of electric charge.?

Ans:- When two or more point charges are present.
the total force is equal to the vector sum of the forces due to each of their other point charges.

→ As force is a vector we cannot algebraically add forces if there is more than one poin charge

The principle of superposition of forces in electrostatics state that when a number of charge are interacting the electrostatics force between two charges and the total electrostatics charge in the vector sum of all force due to other charge.

Part (5) **What is Biot-Savart law? Also state it with the help of expression.**

Ans:- $\frac{}{3}$ The Biot Savart law is an equation describing the magnetic feild generated by a constant electric current. It relates the magnetic feild to the magnitude direction, length and proximity of the electric current.

Biot-Servent law Statment & Derivation:-

The biot-Savart law can be stated as:

Hense $dB \propto \frac{Idl\sin\theta}{r^2}$ or $dB = k\frac{Idl\sin\theta}{r^2}$

Where, k is the constant depending upon the magnetic properties of the medium and system of the unit employed

$$k = \frac{\mu_0\mu_r}{4\pi}$$

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Q→03 Part(B) A free standard linear conductor of length l carries l along the z axis as show in the Fig 5-10 Determine the magnetic flux density B at Point P located at a distance r in the x-y plane.

Ans:- Solution:- The differential length vector $dl = \hat{z}dz$. Hence, $dl \times \hat{R} = dz(\hat{z} \times \hat{R}) = \hat{\phi} \sin\theta dz$ where $\hat{\phi}$ is the azimuth direction and θ is the angle between dl and $\hat{R}'$

$$H = \frac{1}{4\pi}\int \frac{dl \times R}{R^2} = \hat{\phi}\frac{1}{4\pi}\int \frac{\sin\theta}{R^2}$$

Both R and θ are dependent on the intregration variable z but the radial distance r is not

$$R = r\csc\theta \qquad (5.26a)$$

$$z = -r\cos\theta \qquad (5.26b)$$

$$dz = r\csc^2\theta\, d\theta \qquad (5.26c)$$

where θ_1 and θ_2 are the limited angle at $z = -l/2$ $z = l/2$ respectively from the right triangle in Fig it follow that

$$\cos\theta_2 = -\cos\theta_1 = \frac{-l/2}{\sqrt{r^2+(l/2)^2}}$$

Hence.

$$B = \mu_0 H = \hat{\phi}\frac{\mu_0 I l}{2\pi r\sqrt{4r^2+l^2}}$$

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$$B = \mu_0 H = \phi \frac{\mu_0 I l}{2\pi r\sqrt{4r^2 + l^2}}$$

For an infinitely long wire with

$l \gg r$

$$B = \phi \frac{\mu_0 I}{2\pi r} \quad \text{Ans:-}$$

Q→03 The semi-circular conductor show
Part(A) lies in the plane and carries a current. The closed circuit is exposed — — the curved section:-

Ans: The evalute F_1 consider straight section of the circuit is of length $2r$ and its current flows along the $+x$ direction. Application of Eq. (5.12) with $l = x\,2r$ gives

$$F_1 = x(2Ir) \times y B_0 = z\, 2IrB_0$$

The z direction of out of range
The direction length dI on the curved part of circle. The direction of dI is chosen to coincide with the direction of the current

$$F_2 = I\int_{\theta=0}^{\pi} dl \times B$$

$$= -2I\int_{\theta=0}^{\pi} rB_0 \sin\theta \, d\theta = -2IrB_0$$

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Q→04 Part(A) Explain the Farady's Law Also explain in brief its Differential and integral forms.

Farady's Law:- states that the absolute value or magnitude of the circulation of the electrical feild E around a closed loop is equal to the rate change of the magnetic flux through the area enclosed by the loop.
The equation below expresses Farady's law in mathematical form

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

It is a local statment. We first intregate on both sides about an arbitary surface Σ.

$$\int_{\Sigma} \nabla \times E \cdot da = -\int \frac{\partial B}{\partial t} \cdot da$$

On the left hand side of the above equation we use stokes theorm. $\int_{\Sigma} \nabla \times E \cdot da = \int_{\partial\Sigma} E \cdot ds$
where $\partial\Sigma$ is the boundry of the surface. On the right hand side we argue that the surface does'nt change with time therefore the derivative sign can be moved out side of derivative symbole

$$\oint_{\partial\Sigma} E \cdot dl = -\frac{d}{dt}\int_{\Sigma} B \cdot da$$

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Q⇒04
Part(B) Determine voltage V_1 and V_2 across the $2\,\Omega$ and $4\,\Omega$ register show in 6.4. The loop is located in the x-y Plane. its area is $4m^2$ The magnetic flux density is $B = -20.3t\,(T)$ and the internal resistance of the wire may be ignored.

Ans Determine Voltage V_1 and V_2 across the $2\,\Omega$ and $4\,\Omega$ resistors show in Fig 6.4 The loop is located in the x-y plane its area is $4m^2$ the magnetic flux density is $B = -20.3r\,(T)$ and the internal resistance of the wire may be ignored

$$\phi = \int_S B \cdot ds = \int_S (-20.3r) \cdot z\,ds$$

$$= -0.3r \times 4 = -1.2r$$

and the crossresponding transformer emf is

$$V_{emf} = -\frac{d\phi}{dt} = 1.2$$

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Q→02 Part (A) A 2mm diameter copper wire with conductivity of 5.8×10^7 S/m and electron mobility of 0.0032 ($m^2/V \cdot s$) is subject density of the free electrons.

Ans:- I

Given data:-

The density of diameter copper wire conductivity of 5.8×10^7 S/m and mobility of 0.0032 ($m^2/V \cdot s$)

We know the carries concentration (n)

$$= \frac{\text{Avagadro number} \times \text{Density}}{\text{Atomic weight}}$$

The conductivity of copper is

$$n = 8.46 \times 10^{25}\, m^{-3}$$

The electrical conductivity

$$\sigma = \frac{1}{\rho} = \frac{1}{1.73 \times 10^8}$$

We know

$$\sigma = \frac{ne^2\tau}{m}$$

Average time collision

$$\tau = \frac{\sigma m}{ne^2}$$

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Q→02 Part(B) The x-y plane is a charge free boundry .... -- E_2 in medium ..... 2 and(b) the angles θ_1 and θ_2

Ans

$$E_{2x} = E_{1x} \qquad E_{2y} = E_{1y}$$

and

$$D_{1z} = D_{1z} \quad \text{or} \quad \epsilon_2 E_{2z} = \epsilon_1 E_{1z}$$

Hense

$$E_2 = x E_{2x} + y E_{1y} + \bar{z} \frac{\epsilon_1}{\epsilon_2} E_{1z}$$

The tengential components of E_1 and E_2

$$E_1 = \sqrt{E_{1x}^2 + E_{1y}^2} \quad \text{and}$$

$$E = \sqrt{E_{2x}^2 + E_{2y}^2}$$ The angles θ_1 and θ_2 are then given by

$$\tan\theta_1 = \frac{E_{1t}}{E_{1z}} = \sqrt{E_{1x}^2 + E_{1y}^2}$$

$$\tan\theta_2 = \frac{E_{2t}}{E_{2r}} \quad \frac{\sqrt{E_{2x}^2 + E_{2y}^2}}{E_{2r}}$$

$$= \frac{\sqrt{E_{1x}^2 + E_{1y}^2}}{(\epsilon_1/\epsilon_2) E_{1z}}$$

and the two angles are relaated

$$\frac{\tan\theta_2}{\tan\theta_1} = \frac{\epsilon_2}{\epsilon_1}$$

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