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B.Sc. (H) Electronics

V semester

Practical Assignment

Subject : Electromagnetics

Submitted to Dr. Paramjeet sir ji

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Course → B.Sc. (H) Electronics
Year - III Sem - V
Paper Name - Electromagnetics
(Core Course - XII)



Q.1 :- What is difference between Scalar field and vector field? Given three examples of scalar field and vector field quantity.

Sol)

| Scalar Field | Vector Field |
|---|---|
| • It has only magnitude | • It has magnitude and direction |
| • Scalar obey algebraic rules for operations like addition and multiplication | • Vector obey only vector algebra for this purpose. |
| • A scalar can be divided by another scalar. | • A vector cannot be divided by another vector |
| • Example :- ① mass ② Length ③ Time | • Example ① velocity ② Displacement ③ Acceleration |

Q.2 :- Convert the point $P(x=2, y=3, z=5)$ in cylindrical and spherical coordinate system.

Sol) At point P $(x=2, y=3, z=5)$

$$\rho = \sqrt{x^2+y^2} = \sqrt{4+9} = \sqrt{13} = 3.605$$

$$\phi = \tan^{-1}\frac{3}{x} = \tan^{-1}\frac{3}{2} = 56.309^\circ$$

$$z = 5$$

$$r = \sqrt{x^2+y^2+z^2} = \sqrt{4+9+25} = \sqrt{38} = 6.164$$

$$\theta = \tan^{-1}\frac{\sqrt{x^2+y^2}}{z} = \tan^{-1}\frac{\sqrt{13}}{5}$$

$$= \tan^{-1}(0.721) = 35.79^\circ$$

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∴ in cylindrical coordinate

$$\boxed{P(2,3,5) = P(3.605^\circ, 56.305^\circ, 5^\circ)}$$

now in spherical coordinate

$$\boxed{P(2,3,5) = (6.164^\circ, 35.79^\circ, 56.305^\circ)}$$

Q.3 Define Gradient of Scalar field, divergence and Curl of vector fields. What is their significance? Determine the Curl of

$$\vec{A} = \frac{3}{r^3}\sin\theta\cos\phi\,\hat{a}_r + r^2\sin2\theta\cos\phi\,\hat{a}_\theta + r\cos2\theta\,\hat{a}_\phi$$

Sol → Gradient of a scalar field is a vector field and whose magnitude is the rate of charge and with points in direction of greatest rate of increase of the scalar.

The significance of gradient is that it tells us the rate of charge of one variable with respect to another.

→ Divergence of a vector field is the intent to which the vector field then behaves like a source at a given point.
The significance of divergence is that it tells us the rate at which density inits a given surface/space region.

→ The Curl of a vector field is defined as the circulation density at each point in the field. Its significance is that it measures the tendency of the vector field to around.

$$\vec{A} = \frac{3}{r^3}\sin\theta\cos\phi\,\hat{a}_r + r^2\sin2\theta\cos\phi\,\hat{a}_\theta + r\cos2\theta\,\hat{a}_\phi \text{ —— (Given)}$$

As we know

$$\text{Curl } \vec{A} = \vec{\nabla}\times\vec{A}$$

$$= \frac{\hat{a}}{r\sin\theta}\left[\frac{d}{d\theta}(A_\phi\sin\theta) - \frac{d}{d\phi}A_\theta\right] + \frac{a\hat{\theta}}{r\sin\theta}\left[\frac{\delta}{\delta\phi}A_r - \sin\theta\frac{d}{dr}(rA_\phi)\right]$$
$$+ \frac{a\hat{\phi}}{r}\left[\frac{d}{dr}(rA_\theta) + \frac{d}{d\theta}(A_r\right.$$

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$$= \frac{a\hat{r}}{r\sin\theta}\left[\frac{d}{d\theta}\left(\frac{3\sin^2\theta\cos\phi}{r^3}\right) - \frac{\delta}{\delta\phi}\left(\frac{r^2\sin 2\theta}{\cos\phi}\right)\right] +$$

$$+ \frac{a\hat{\theta}}{r\sin\theta}\left[\frac{d}{dr}\left(\frac{3\sin^2\theta\cos\phi}{r^3}\right) - \sin\theta\frac{d}{\delta r}(r^2\cos 2\theta)\right]$$

$$+ \frac{a\hat{\phi}}{r}\left[\frac{d}{dr}(r^2\sin 2\theta\cdot\cos\phi) - \frac{\delta}{\delta\theta}\left(\frac{3\sin\theta\cos\phi}{r^3}\right)\right]$$

$$= a\hat{r}\left[\frac{3\sin^2\theta\cos\phi}{r^3(r\sin\theta)} + \frac{r^2\sin 2\theta\sin 2\phi}{r\sin\theta}\right] + a\hat{\theta}\left[-\frac{9\sin^2\theta\cos\phi}{r^4 r\sin\theta}\right.$$

$$\left. - \frac{2r\sin\theta\cos 2\theta}{r\sin\theta}\right] + \phi\hat{a}\left[\frac{3r^2\sin 2\theta\cos\phi}{r} - \frac{3\cos\theta\cos\phi}{r^4}\right]$$

$$\therefore \text{Curl }\vec{A} = a\hat{r}\left[\frac{6\cos\theta\cos\phi}{r^4} + r\cos\theta\sin\phi\right]$$

$$+ a\hat{\theta}\left[\frac{-9\sin\theta\cos\theta}{r^5} - 2\cos 2\theta\right]$$

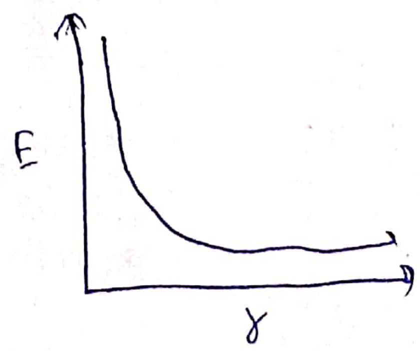
$$+ a\hat{\phi}\left[3r\sin 2\theta\cos\phi - \frac{3\cos\theta\cos\phi}{r^4}\right]$$

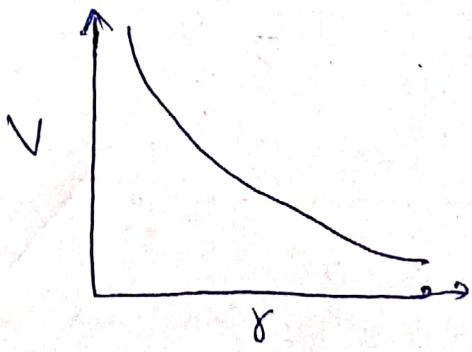
Q-4 :- What is Electric field and Electric potential due to spherical charge distribution? How these varies with distance.

Sol) At a point outside the charged ~~sol~~ Sphere;

$E = \frac{\sigma R^2}{E_0 r^2}$ [E is inversely proportional to distance $r^2$]

and $V = \frac{\sigma R^2}{E_0 r}$ [V is inversely prop. to distance r]



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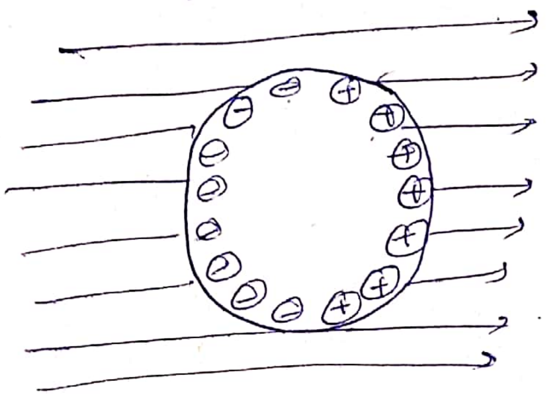
Q.5 :- Why the electric field is zero in conductor ?

Sol ~~A Conductor is~~

The electric field is zero in conductor because the net charge inside a conductor remains zero, the total charge of conductor resides on its surface, as charges want to attain equilibrium so they come on surface, to minimize the repulsion among them. As the charge inside a conductor is zero therefore, if we apply ~~gauss~~ Gauss theorem to find the electric field inside a conductor, we find it zero.



Q.6 :- Explain the polarization in the diectric ?

Sol Dielectric polarization is defined as the electric field is applied throughout the material, then the charge will be redistributed and the dielectric will be polarized.

In sime terms, the charge in the material arrange themselves to get acted upon the least repulsion. The negative charges get accumulated in the more positive side of ~~electron~~ $\vec{E}$ while positive charges get the more negative.

The polarization of any material is defined as the amount of dipole moment per unit volume.

$$P = n \alpha E$$

Where, P is polarization | $\alpha$ is polarization | E is the local electric field.

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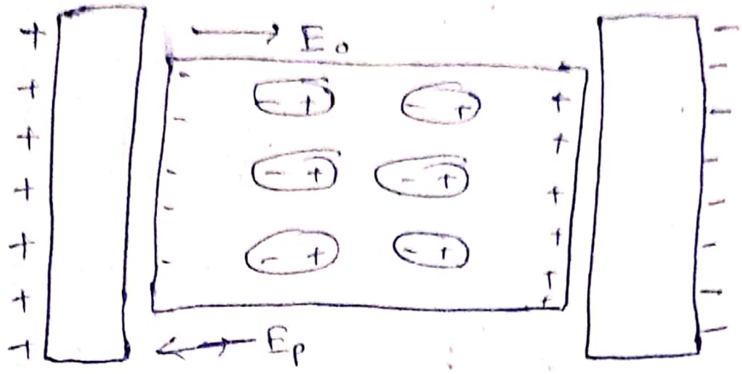


**Q-7 :** What is method of image? What is the application of this method?

**Sol** ⇒ The method of images on the method of mirror equation in which a mathematical tool for drawing differential equation, in which the domain of the sought functions is extended by the addition of its mirror image with respect to a symmetry hyperplane. As a result certain boundary conditions are satisfied automatically by the presence of a mirror image.

⇒ The application of the method of ~~a~~ image is that it is used to simply calculate or visuabse the distribution of the electric field in a change in the intensity of a conducting surface.

**Q-8 :** What is the direction of magneric field due to a current carrying wire? Write the expresion for it.

**Sol** The direction of the magnetic field ~~due to~~ is perpendicular to the wire. If you wrap your fingers (right hand) around the wire ~~so~~ with your thumb pointing in the direction of current then the direction in which your finger would curve will give the direction of the magnetic field.

$$\boxed{B = \frac{\mu_0 I}{4\pi a}(\sin\theta_1 + \sin\theta_2)}$$

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Q-9 Write Maxwell's equation in point and integral form. (5)

Sol

| Point Form | Integral form |
|---|---|
| $\nabla \cdot \Delta = \rho v$ | $\oint_S D \cdot ds = \int_V \rho v \cdot dv = Q$ |
| $\nabla \times E = -\frac{\delta B}{\partial t}$ | $\oint_c E \cdot dl = -\int_S \delta B/\delta t \cdot ds$ |
| $\nabla \cdot B = 0$ | $\oint_S B \cdot ds = 0$ |
| $\nabla H = J + \frac{\delta \Delta}{\delta t}$ | $\oint_c H \cdot dl = \int_S (J + dD/dt) \cdot ds$ |

Q-10 Define a mode supported by a waveguide. What are different types of modes that can exist in a rectangular waveguide? How rectangular wave guide is different from coaxial transmission line.

Sol ⇒ Wave guide mode stands for a unique distribution of transversal and longitudinal components of the electric and magnetic fields.

⇒ A rectangular ~~tap~~ waveguide supports TM and TE mode.

⇒ As a waveguide is semi-filled there will be less loss compared to coaxial line in waveguide, no power is lost through radiation. ~~this~~ so even dielectric loss is negligible. waveguide can handle higher power as compared to coaxial - transmission line.

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