18EC55 EMW IAT-2 2020

Question paper is designed for 1 hour additional 15 mints will be given for scanning and uploading.

* Required

1. Email *

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2. The divergence of a vector field is a vector quantity. 2 points

Mark only one oval.

- True Always
- Sometimes True and Sometimes False
- False Always

3. *

4 points

a vector

$$\vec{A} = 3.4\hat{x} + 4.1\hat{y} + 2.5\hat{z},$$

the divergence of the vector is $\longrightarrow$

Mark only one oval.

$3.4\hat{x} + 4.1\hat{y} + 2.5\hat{z}$

$0.34\hat{x} + 0.41\hat{y} + 0.25\hat{z}$

- a)
- b)
- c) 5.884
- d) 0

4. * 4 points

Given a scalar field $f(x, y, z)$ and vector field $\vec{D}(x, y, z)$, which of the following operations is not allowed?

Mark only one oval.

$$(\nabla f).\vec{D}$$

A)

$$\nabla.(\nabla f)$$

B)

$$\nabla.(\nabla \times \vec{D})$$

C)

$$(\nabla \times f).\vec{D}$$

D)

5. Poisson's equation is the simplified version of Laplace's equation under no charge condition. * 2 points

Mark only one oval.

True

False

6. Scalar Laplacian operation on the scalar field to produce another scalar field is equivalent to * — 4 points

Mark only one oval.

- Divergence followed by curl operation
- Curl operation followed by divergence operation
- Divergence operation followed by gradient operation
- Gradient operation followed by divergence operation

7. The work done by the electric field to on a particle charge 'Q', when it is moved from point A to point B on an equipotential surface with having a displacement of 'D' is — 4 points

Mark only one oval.

- 0
- Infinite
- Q*D
- (9x10^9)*Q/D

18EC55 EMW IAT-1 2020 [Part- A, Subjective Questions]

Attempt any 3 questions in this section and upload a single file (only PDF/Image)

8. Attempt any 3 questions in this section and upload a single file (only PDF/Image) [Also upload the rough work done to solve the objective problem, this will be also consider for proper valuation] 30 points

Q1. A 15-nC point charge is at the origin in free space. Calculate V_1 if point P_1 is located at $P_1(-2, 3, -1)$ and (*a*) $V = 0$ at infinity ; (*b*) $V = 0$ at $(6, 5, 4)$; (*c*) $V = 5$ V at $(2, 0, 4)$.

Q2. Derive the point form the current Continuity Equation

Q3. Derive the LAPLACE'S and POISSON'S Equations

Q4. Two infinite length, concentric and conducting cylinders of radii a and b are located on the z axis. If the region between cylinders are charged free and $\epsilon_r = 4$, V = V_0 (V) at a, V = 0 (V) at b and b > a. Find the capacitance per meter length. Given

$$\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \frac{\partial V}{\partial \rho}\right) + \frac{1}{\rho^2}\left(\frac{\partial^2 V}{\partial \phi^2}\right) + \frac{\partial^2 V}{\partial z^2}$$

$$\nabla V = \frac{\partial V}{\partial \rho}\mathbf{a}_\rho + \frac{1}{\rho}\frac{\partial V}{\partial \phi}\mathbf{a}_\phi + \frac{\partial V}{\partial z}\mathbf{a}_z$$

Files submitted:

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EMW IAT2

Q1. Soln:- (a) $V_{P_1} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$

$$= \frac{1 \times 15\times10^{-9}}{4\pi\times8.854\times10^{-12}\times\sqrt{4+9+1}}$$

$$\boxed{V_{P_1} = 36.03V}$$

(b) $V_{P_1} = 36 - V$

$$= 36 - \frac{1 \times 15\times10^{-9}}{4\pi\times8.854\times10^{-12}\times\sqrt{36+25+16}}$$

$$= 36 - 15.3637$$

$$\boxed{V_{P_1} = 20.63V}$$

(c) $V_{P_1} = 36 - V + 5$

$$= 41 - V$$

$$= 41 - \frac{1 \times 15\times10^{-9}}{4\pi\times8.854\times10^{-12}\times\sqrt{4+16}}$$

$$= 41 - 30.1458$$

$$\boxed{V_{P_1} = 10.8542\ V}$$

Q2 Soln: CONTINUITY EQUATION:

The continuity equation is considered for

The outward flow of positive charge must be balanced by a decrease of positive charge within closed surface. If the charge inside the closed surface is denoted by Q_i, then rate of charge flow decreases by $\boxed{-\frac{dQ_i}{dt}}$ and the principle of conservation of charge requires

$$\boxed{I = -\frac{dQ_i}{dt} \Rightarrow I = \oint_S J \cdot dS = -\frac{dQ_i}{dt}}$$

Using the divergence theorem,

$$\boxed{\oint_S J \cdot dS = \int_{vol} (\nabla \cdot J)\, dV}$$

$$\Rightarrow \int_{vol} (\nabla \cdot J)\, dv = -\frac{d}{dt} \int_{vol} \rho_v \, dv$$

$$\int_{vol} (\nabla \cdot J)\, dv = \int_{vol} -\frac{\partial \rho_v}{\partial t}\, dv$$

One point form of continuity equ is,

$$\boxed{\nabla \cdot J = -\frac{\partial \rho_v}{\partial t}}$$

3 Ans:- DERIVATIONS OF LAPLACE'S AND POISSON'S EQUATION:

Using the gradient Concept,

$$\bar{E} = -\nabla V \quad \text{——— (2)}$$

From equ. (1),

$$\nabla \cdot [\varepsilon \cdot \bar{E}] = \rho_v \quad \text{——— (3)}$$

Using (2) in (3),

$$\nabla \cdot [\varepsilon \cdot (-\nabla V)] = \rho_v$$

$$\nabla \cdot \nabla \cdot -V = \frac{\rho_v}{\varepsilon}$$

$$\nabla \cdot \nabla V = \frac{-\rho_v}{\varepsilon} \quad \text{——— (4)}$$

W.K.T, $\nabla \cdot \nabla = \nabla^2$

$\therefore$ Equ (4) becomes, $\boxed{\nabla^2 V = \frac{-\rho_v}{\varepsilon} \; V/m^2}$ ——— (5)

Equ. (5) is defined as POISSON'S EQUATION if applied to a HOMOGENOUS MEDIA

When the free charge density, i.e., $\rho_v = 0$,

then, Equ (5) becomes, $\boxed{\nabla^2 V = 0 \quad V/m^2}$ ——— (6)

Equ. (6) is defined as LAPLACE'S EQUATION when free charge density = 0.

In rectangular co-ordinates; $\nabla^2 V$ is defined as follows applicable to both Equ (5) and (6),

MCQ's

2. $\vec{A} = 3.4\,\hat{x} + 4.1\,\hat{y} + 2.5\,\hat{z}$

$Div(A) = \,?$

$$Div(A) = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$$

$$= \frac{\partial}{\partial x}(3.4) + \frac{\partial}{\partial y}(4.1) + \frac{\partial}{\partial z}(2.5)$$

$$= 0 + 0 + 0$$

$$\boxed{Div(A) = 0}$$

1. False Always

3. $(\nabla . f) . \vec{D}$ = (Vect. Scalar) . Vector
vect. scalar — Vector
vector . vector

$\nabla . (\nabla f)$ = ✓
vector vect sc
vector . vect

$\nabla . (\nabla \times \vec{D})$ = Vector
Vect . Scalar

• $(\nabla \times f) . \vec{D}$ =
vector scalar
vector . vector

4. False