Roll No.:

National Institute of Technology Delhi

B. Tech. (Mid-semester Examination, Autumn Sem., 2022-23)

Branch: ECE **Semester:** 1st

Title of the Course: Engineering Physics **Course Code:** PHB101

Time: 1.5 Hours **Max. Marks:** 25

Note: Attempt all questions. Show corresponding calculation/derivation steps, wherever applicable.

(Section-A: 10 Questions of 1 marks each)

A1. Which one is the incorrect option for the vectors **A** and **B**:

(a) $\mathbf{A.B = B.A}$ **(b)** $\mathbf{A.(B+C) = A.B + C.A}$

(c) $\mathbf{A+B = B+A}$ **(d)** $\mathbf{A\times(B+C) = A\times B + C\times A}$

A2. The Laplacian of the scalar field $f(x, y, z) = xy^2 + z^3$ is:

(a) 0 **(b)** $2x + 6z$ **(c)** $xy^2 + z^3$ **(d)** $y^2 + 4xy + 3z^2$

A3. The electric field strength at a point situated at equal distance of 5 cm away from two equal (one positive and another negative) charges of 10^{-8} C, which are 8 cm apart from each other is:

(a) 0
(b) 5.76×10^4 V/m
(c) 5.76×10^3 V/m
(d) 6.75×10^5 V/m

A4. If **P** and **E** are the polarization and electric field vectors, respectively, then the magnitude of bound charge density (ρ_b) is best represented by which of these:

(a) $\rho_b = \nabla.\mathbf{E}$ **(b)** $\rho_b = \nabla.(\varepsilon\mathbf{E} + \mathbf{P})$ **(c)** $\rho_b = \nabla.\mathbf{P}$ **(d)** $\rho_b = \nabla.(\mathbf{P} \times \mathbf{E})$

A5. Which statement does not hold true for a conductor:

(a) There is no net electric field inside it
(b) Any net charge can only reside at its surface
(c) A conductor is an equipotential
(d) There is a finite net volume charge density inside it

A6. Calculate the divergence of vector $\mathbf{F} = (2xy, z, yz^2)$ at a point (2, -1, 3).

A7. The electric potential is generally defined as the following expression:

$$V(\mathbf{r}) \equiv -\int_{\mathcal{O}}^{\mathbf{r}} \mathbf{E} \cdot d\mathbf{l}$$

Sharply explain the physical significance of the negative sign in above expression?

A8. Check, with proper logic, if the vector field (**v**) with following components is an irrotational one:

$$\mathbf{v}_a = \mathbf{r} = x\,\hat{\mathbf{x}} + y\,\hat{\mathbf{y}} + z\,\hat{\mathbf{z}},\ \mathbf{v}_b = \hat{\mathbf{z}},\ \text{and}\ \mathbf{v}_c = z\,\hat{\mathbf{z}}.$$

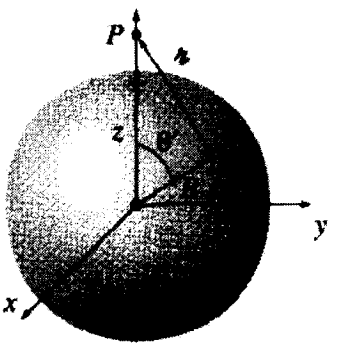
A9. Briefly discuss the Ampere's law for steady current with its differential form.

A10. For a sphere of radius '**R**' (centered at the origin), the charge density is given by following expression: $\rho = 5\varepsilon_0 k r^2$. Find out the net charge contained in the sphere.

(Section-B: 5 questions of 3 marks each**)**

B1. Verify the BAC-CAB rule for following vectors: $\mathbf{A} = 3\boldsymbol{i} - 2\boldsymbol{j} + \boldsymbol{k}$, $\mathbf{B} = 2\boldsymbol{i} - 4\boldsymbol{j} - 3\boldsymbol{k}$, and $\mathbf{C} = -\boldsymbol{i} + 2\boldsymbol{j} + 2\boldsymbol{k}$.

B2. Find the potential of a uniformly charged spherical shell of radius '**R**' at point P as depicted in the figure. (The surface charge density is σ)



B3. Write short notes on:

(a) '*Magnetic monopoles do not exist*'

(b) Conservative nature of Electrostatic field

(c) '*Magnetic forces do no work*'

B4. For a vector given as: $\mathbf{F} = (3x^2 + 6y)\boldsymbol{i} - 14yz\,\boldsymbol{j} + 20xz^2\,\boldsymbol{k}$, find out $\oint \boldsymbol{F}.\boldsymbol{dl}$ along the straight line from (0, 0, 0) to (1, 0, 0), then to (1, 1, 0), and then to (1, 1, 1). (*Show the corresponding diagram*)

B5. Discuss (*i*) Gauss' divergence theorem, and (*ii*) Fundamental theorem of gradient with their statements, expressions, and physical interpretations.

--- End of the question paper ---