भौतिकी विभाग
मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
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20223035

Mid-Semester (Odd) Examination

Date: 27.12.2022 **Exam timings:** 9:30 AM - 11:00 AM **Maximum Marks:** 20

Program: B.Tech. **Session:** 2022-23
Course Code: PH11101 **Course Name:** Engineering Physics-I
Registration No.: ... **Name of Student:**...

Instructions: Attempt all questions. Marks are shown on the right side of each question.

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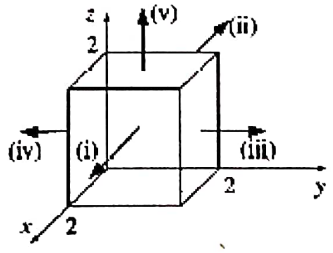
1. Determine divergence of following vector field: [2 Marks]

$$\vec{A} = r\sin\phi\hat{r} + r^2 z\hat{\phi} + z\cos\phi\hat{z}.$$

2. Determine curl of following vector field: [2 Marks]

$$\vec{B} = r\cos\theta\hat{r} + r\sin\theta\hat{\theta} + r\sin\theta\cos\phi\hat{\phi}.$$

3. Calculate the surface integral of $\vec{v} = 2xz\hat{i} + (x+2)\hat{j} + y(z^2-3)\hat{k}$ over five sides (excluding the bottom) of the cubical box shown in the figure. Let "upward and outward" be the positive direction, as indicated by arrows in the following figure. [3 Marks]



4. Consider two concentric spherical shells of radius a and b with $b > a$. If inner shell has total charge q uniformly distributed over it, and outer shell is at potential V_0, evaluate the potential at any point between the shells using the Laplace equation. [4 Marks]

5. Show that the loop integral of the magnetic vector potential over the boundary of a surface is equal to magnetic flux passing through the surface, *i.e.*, [2 Marks]

$$\oint_l \vec{A}\cdot d\vec{l} = \iint_S \vec{B}\cdot d\vec{S}.$$

6. Show that the electric and magnetic fields in an electromagnetic wave are perpendicular to each other, and are also perpendicular to the direction of the propagation of the wave. [3 Marks]

7. Write the Maxwell equations in free space in its differential and integral forms. [2 Marks]

8. A parallel plate capacitor is being charged such that the charge on its plate at any time, t is given by the $q(t) = q_0(1 - e^{-\alpha t})$. Calculate the displacement current. [2 Marks]

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