Assignment 2

Due on 2020-09-30, 23:59 MST. 1 point

1. An infinitely long current carrying conductor passes through \((0,0,0)\) and \((0,0,2)\), and current is in the positive z-direction. Find the unit vector of \(\mathbf{E}\) at point \((1,1,3)\).

\[ \mathbf{E} = \frac{\lambda}{2\pi\varepsilon_0 r^2} \hat{z} \]

2. Find the curl-normal vector for the surface of an infinitely long cylinder in Cartesian system at point \((0,0,1)\) with its axis passing through \((0,0,0)\) and radius \(a\).

\[ \mathbf{n} = \frac{1}{a} (y, -x, 0) \]

3. Magnetic field in a certain region is represented by \( \mathbf{B} = 2\mathbf{a}_x + 3\mathbf{a}_y \), find the value of \( \mathbf{E} \) at point \((1,2,3)\).

\[ \mathbf{E} = -\nabla \times \mathbf{B} = \nabla \times (2\mathbf{a}_x + 3\mathbf{a}_y) \]

4. To obtain the magnetic field distribution inside the shaded region in the following figure, state the direction of the magnetic vector potential \( \mathbf{A} \), the angle \( \theta \) is independent of \( x \) variable and the component is zero.

\[ \mathbf{B} = \mu_0 \nabla \times \mathbf{A} \]

5. In the absence of any surface currents, magnetic flux density vectors are passing from medium 1 (\( \varepsilon = 400 \)) to medium 2 (\( \varepsilon = 2000 \)). \[ \mathbf{E} = 0 \] at the interface in medium 1, find \( \mathbf{E} \) in medium 2.

\[ \varepsilon_1 \varepsilon_0 \mathbf{E}_1 = \varepsilon_2 \varepsilon_0 \mathbf{E}_2 \]

6. Permeability of a magnetic material is assumed to be infinite. What will be the direction of \( \mathbf{B} \) in the air, any closer to the air magnetic material interface?

\[ \theta = 90^\circ \]

7. A coil turns rectangular loop is placed in XY plane with its sections at \((0,0,1)\), \((1,0,1)\), and \((1,1,1)\), the uniform transversal field \( \mathbf{B} = \frac{1}{2}\mu_0 \varepsilon_0 \hat{z} \times \mathbf{A} \). Estimate the peak value of the induced emf in the loop. If the dimensions are in meters.

\[ \mathcal{E} = N \frac{d\Phi_B}{dt} \]

8. In this cylindrical conductor of length \( l = 10 \text{ cm} \) (along z direction) is moving in direction perpendicular to its axis in a xy plane at constant velocity \( v = 2 \text{ m/s} \). If the field \( \mathbf{B} = 1 \text{ T} \), \( \mathbf{E} \) present in the region, what is the magnitude of induced emf in this conductor?

\[ \mathcal{E} = l \mathbf{v} \times \mathbf{B} \]

9. Infinite rigid current density on the surface of an abdominal plate is \( \sigma_0 = 500 \text{ A/m} \). What will be the peak magnetic density at the depth of c from the plate surface? Conductivity of aluminum is \( c = 37 	imes 10^6 \text{ S/m} \).

\[ D = \sigma_0 \varepsilon_0 \mathbf{E} \]

10. A transmission line conductor shown in the figure, the components of \( \mathbf{E} \) and \( \mathbf{B} \) that are responsible for power loss are

\[ \mathbf{E}_p \] and \( \mathbf{B}_p \]

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