國立中央大學112學年度碩士班考試入學試題

所別： 光電類

科目： 電磁學

計算題應詳列計算過程，無計算過程者不予計分

1. An infinitely long ferromagnetic cylinder of radius R is magnetized to have the magnetization

$$\mathbf{M}(r) = kr\hat{z}$$

inside the cylinder. Here k is a constant, r is the distance measured from the central axis of the cylinder, and $\hat{z}$ is the unit vector in the direction of the cylinder axis.

(a) (10pt) Find the magnetic induction **B** and magnetic field **H** inside and outside the cylinder due to $\mathbf{M}(r)$.

(b) (10pt) Find the vector potential corresponding to the **B** field obtained in (a).

2. (10pt) The permittivity ε and permeability μ for medium I and II are (ε_1, μ_1) and (ε_2, μ_2), respectively, and they have a common boundary (interface). Assume that there are no free charge density and free current density in these two media and the interface, namely: $\rho_{free} = 0$, $\boldsymbol{J}_{free} = 0$, $\sigma_{free} = 0$, $\mathbf{K}_{free} = 0$.
Derive the boundary conditions for the **D** field (electric displacement) and the **H** field (note that it is not the **B** field) at the interface from Maxwell's equations.

3. (20pt) The axis of an infinitely long tube of rectangular cross-section $a \times b$ is parallel to the z axis. The four walls of the tube are located at $x = 0$, $x = a$, $y = 0$, and $y = b$, respectively. The potential $V = V_0 \sin\left(\frac{3\pi x}{a}\right)$ is applied to the upper wall (at $y = b$), and the remaining three walls are grounded. Find the electric field **E** inside the tube.

4. At the origin located two radiation elements: an electric dipole of length L, carrying an alternating current $\tilde{\mathbf{I}}_1 \sin(\omega t)$; and a magnetic dipole consisting of a wire loop of radius b carrying current $\tilde{\mathbf{I}}_2 \cos(\omega t)$. Find the condition so as to produce a right-circularly polarized wave at any point in the far field. Note that you need to specify the relative orientations, phase and magnitude of the currents between the electric dipole and the magnetic dipole. (20 pts).

5. Consider a perfectly conducting spherical shell of radius a rotates about the z-axis with angular velocity ω in a uniform magnetic field $B_0\hat{z}$. Calculate and show that the electromotive force (emf) developed between the north pole and the equator equals to that of a disk of the same radius rotates about the z-axis. (20 pts).

注意:背面有試題

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6. (a) Give your design of an 80 Ω coaxial transmission line using a Cu wire and tube, and filling material with a relative permittivity ε_r=2.25. Note that you need to specify the geometric parameters. (5 pts).
(b) Consider a wave operated at 2 GHz with an average power of 100 kW, find the peak electric field on this transmission line. (5 pts).

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