八十五學年度國立台灣工業技術學院研究所碩士班招生考試

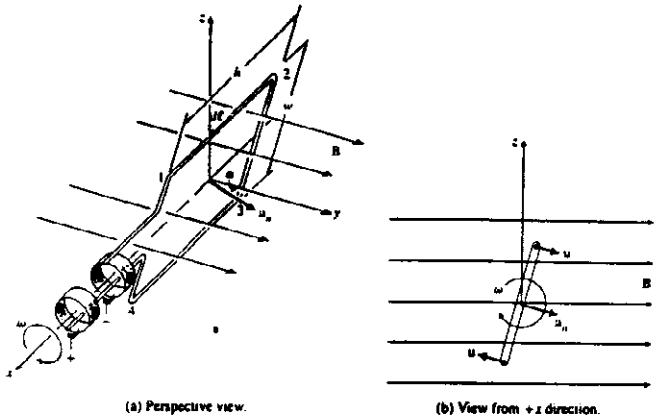
所別：電子工程技術研究所　　組別：系統組　　科目：電磁學

1. Consider a point charge q at the origin and a spherical shell of dielectric ϵ_r between $R = a$ and $R = b$, $b > a$. Determine
   (a) the electric flux density $\vec{D}$, everywhere. (5%)
   (b) electric field intensity $\vec{E}$. everywhere. (5%)
   (c) electric field potential V. everywhere. (5%)
   (d) the polarization vector $\vec{P}$ and the bound volume charge density in the region $a < R < b$, the bound surface charge densities on the surface at $R = b$, and on the surface at $R = a$ (10%).

2. A cubical region of a side length b has the following potential distribution on its six walls.
   $V(x, y, z) = 0$ at $x = 0, x = b, y = o, y = b$, and $z = 0$
   $V(x, y, z) = V_0 \sin \frac{3\pi}{b} x \sin \frac{4\pi}{b} y$, at $z = b$.
   The interior region is free of charge. Find
   (a) the electric potential $V(x, y, z)$ inside the cube, (10%)
   (b) the $\vec{E}$ field inside the cube. (7%)

3. A steady(transport) current distribution expressed in cylindrical coordinate
   $$\vec{J}_0 = \vec{a}_z J_0 \exp(-\frac{r}{a})$$
   J_0 and a are constants.
   (a) Find the magnetic field intensity $\vec{H}$ everywhere. (10%)
   (b) What is the magnetization $\vec{M}$ everywhere? (5%)

4. An h by w rectangular loop is situated in a changing magnetic field $\vec{B} = \vec{a}_y B_0 \sin \omega t$. The normal of the loop initially makes an angle α with $\vec{a}_y$, as shown in the following Fig. Find the induced emf in the loop:
   (a) when the loop is at rest, (10%)
   (b) when the loop rotates with an angular velocity ω about the x-axis. (10%)



(a) Perspective view.　　(b) View from +z direction.

5. A plane time-harmonic electromagnetic wave propagating in a dielectric medium of $\epsilon = 3.0\epsilon_0$ has the following complex(phasor) electric field:
   $$\mathbf{E} = (3j\vec{a}_x + \vec{a}_y) \exp(j3z)$$
   The $\exp(-j\omega t)$ time-dependence is assumed.
   (a) What is the radial frequency and wavelength of this plane wave? (5%)
   (b) Find the real time-dependent electric field $\vec{E}(r, t)$ and determine what polarization it has. (5%)
   (c) What is the complex(phasor) magnetic field $\mathbf{H}$ of this wave? (7%)
   (d) Find the time-average Poynting vector $P_{av}(z)$. (6%)