國立臺灣大學 108 學年度碩士班招生考試試題

1. (15%) A circular loop of wire of radius a is situated in the xy-plane with its center at the origin. It carries a current I in the clockwise sense as seen along the positive z-axis. Find the magnetic flux density $\vec{B}$ due to the current loop at a point on the z-axis.

2. (15%) The forces experienced by a test charge q at a point in a region of electric and magnetic fields $\vec{E}$ and $\vec{B}$, respectively, are given as follows.

$$\vec{F}_1 = 0 \quad \text{for } \vec{v}_1 = v_0\vec{a}_x$$
$$\vec{F}_2 = 0 \quad \text{for } \vec{v}_2 = v_0\vec{a}_y$$
$$\vec{F}_3 = qE_0\vec{a}_z \quad \text{for } \vec{v}_3 = v_0(\vec{a}_x + 3\vec{a}_y)$$

where v_0 and E_0 are constants. Find the force experienced by a test charge q at that point for the velocity $\vec{v}_4 = v_0(3\vec{a}_x + \vec{a}_y)/5$.

3. (15%) A magnetic field is given in the xz-plane by $\vec{B} = (B_0/x)\vec{a}_y$ Wb/m^2. Consider a rigid rectangular loop situated in the xz-plane with its corners at (x_0, 0, z_0), (x_0, 0, z_0+b), (x_0+a, 0, z_0+b), and (x_0+a, 0, z_0). Find the induced emf if the loop is moving with the velocity $\vec{v} = v_0\vec{a}_x$ m/s.

4. (15%) A coaxial cable consists of an inner conductor of radius $3a$ and an outer conductor of inner radius $4a$ and outer radius $5a$. Assume the cable to be infinitely long and its axis to be along the z-axis. Current I flows with uniform density in the $+z$-direction in the inner conductor and returns with uniform density in the $-z$-direction in the outer conductor. Find $\vec{H}$ everywhere.

5. (15%) The electric field of a uniform plane wave in free space is given by

$$\vec{E} = E_0\cos(\omega t - \beta z)\vec{a}_x - E_0\cos(\omega t - \beta z + \pi/2)\vec{a}_y \text{ V/m}$$

(a) Find the polarization of the wave.
(b) Find the associated magnetic field $\vec{H}$.
(c) Find the instantaneous Poynting vector.

6. (25%) The electric field of a uniform plane wave propagating in a perfect dielectric medium having $\mu = \mu_0$ is given by

$$\vec{E} = 2\cos(3\times10^6 t + 0.1x)\vec{a}_z \text{ V/m}$$

(a) (9%) Find the frequency, the wavelength, and the phase velocity.
(b) (6%) Find the permittivity and the intrinsic impedance of the medium.
(c) (5%) Find the associated magnetic field $\vec{H}$.
(d) (5%) Find the time-average Poynting vector.

試題隨卷繳回