



國立臺灣海洋大學一〇〇學年度研究所碩士班暨碩士在職專班入學考試試題

考試科目：電磁學

系所名稱：光電科學研究所碩士班不分組

※可使用計算器

1.答案以橫式由左至右書寫。2.請依題號順序作答。

1. (10%) A vector field is given by the expression: $\vec{A}(x, y) = abx \sin(by)\hat{i} + a \cos(by)\hat{j}$, where a and b are constant. Could this field be a magnetic field?

2. (10%) Find the rate of change with time of the magnetic field at a location at which the induced electric field is given by

$$\vec{E}(x, y, z) = E_0 \left[\left(\frac{z}{z_0} \right)^2 \hat{i} + \left(\frac{x}{x_0} \right)^2 \hat{j} + \left(\frac{y}{y_0} \right)^2 \hat{k} \right].$$

3. (10%) A square loop of wire of edge length a carries current i . Show that, at the center of the loop, the magnitude of the magnetic field produced by the current is

$$B = \frac{2\sqrt{2}\mu_0 i}{\pi a}.$$

4. (10%) A charge q is distributed uniformly around a thin ring of radius r . The ring is rotating about an axis through its center and perpendicular to its plane, at an angular speed ω .

(a) What is the magnitude of the magnetic moment due to the rotating charge?

(b) What is the direction of this magnetic moment if the charge is positive?

5. (25%) The magnetic component of a polarized wave of light is given by

$$B_x = (4.0 \times 10^{-6} \text{ T}) \sin[ky + (2.0 \times 10^{15} \text{ s}^{-1})t]$$

(a) In which direction does the wave travel?

(b) Parallel to which axis is it polarized?

(c) What is its intensity?

(d) What is the wavelength?

(e) In which region (for example: ultraviolet, visible, infrared) of the electromagnetic spectrum is this electromagnetic wave?

6. (10%) A point source of light is embedded near the flat surface of a dielectric with index of refraction n . Treat the emitted light as a collection of plane waves (light rays) that propagate isotropically away from the source. Find the fraction of light rays that can refract out of the dielectric into the vacuum space above.

7. (15%) The electric field $\vec{E} = Z^2 y \cos(10^8 t) \hat{x}$ is applied to a dielectric material of ϵ_r .

Determine the following:

(a) The electric polarization, \vec{P} .

(b) The induced polarization charge density, ρ_p .

(c) The polarization current density, J_p .

8. (10%) Calculate the per unit length capacitance of a cylindrical capacitor with inner conductor radius a and outer conductor radius b . The volume between the electrodes is filled with two dielectrics with permittivity ϵ_1 and ϵ_2 . Dielectric 1 fills the volume $a \leq r < R$ and dielectric 2 the volume $R \leq r < b$. A cross section of the capacitor is in the figure below.

