國立台灣科技大學九十七學年度碩士班招生試題

系所組別：電子工程系碩士班乙三組、丙組

科　　目：電磁學

總分 100 分

1. Write the differential form of Maxwell's equations. Then, discuss the origin or source of electric fields and the origin of magnetic fields.[18%].

2. A long straight coaxial cable consists of an inner conductor of radius a and an outer conductor whose inner radius is b. The space between the conductors is filled with a dielectric, and the length of the cable is L (L>>a, L>>b). The permittivity of free space is ε_o.

(A) If the inner and outer conductors carry uniform charge of +Q and - Q, respectively, determine the potential V and polarization vector **P** inside the dielectric as functions of radial distance r, if the dielectric constant of the dielectric is ε_r. [12%].

(B) Does the electric displacement **D** always have the same direction as the electric field **E** in a dielectric? Explain. [4%]

3. A voltage source V is applied, through lossless conducting wires, across a parallel-plate capacitor of area S. The space between the conducting plates is filled with two different lossy dielectrics of thickness d_1 and d_2, permittivities ε_1 and ε_2, and conductivities σ_1 and σ_2, respectively. The positive polarity of the source is connected to the dielectric with thickness d_1. Neglect fringing effect at the edges of the plates.

(A) Determine the conduction current density **J** between the plates and the surface charge density ρ_{si} at the interface between the dielectrics, if V is a constant. [12%].

(B) Find the displacement currents in the capacitor, if the voltage source is a sinusoidal a-c voltage source of amplitude Vo and angular frequency ω. [4%].

國立台灣科技大學九十七學年度碩士班招生試題

系所組別：電子工程系碩士班乙三組、丙組

科　　目：電磁學

4. A uniform sinusoidal plane wave in air with the phasor expression for electric field intensity as follows

$$\vec{E}_i(x, y, z) = \hat{a}_y \, 10 \, e^{-j(6x + 8z)} \quad \text{(Volt / meter)}$$

is incident on a dielectric medium at z = 0, as shown in Fig. p4.

(a) Find the frequency and wavelength of the wave. (10%)

(b) Find the reflection coefficient Γ. (10%)

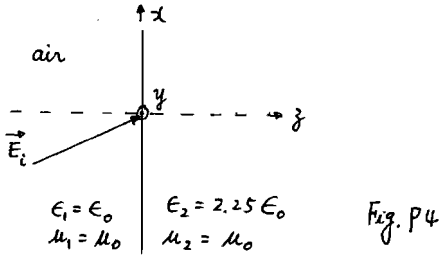


Fig. p4

5. In Fig. p5, the steady state is established on the lossless transmission line with switch S open. Z_o and l are the characteristic impedance and physical length of the transmission line, respectively. At t = 0, switch S is closed. With T = l / u, where u is the propagation velocity of signal, sketch

(a) v (z = 0, t) for all t. (10%)

(b) v (z = l, t) for all t. (10%)

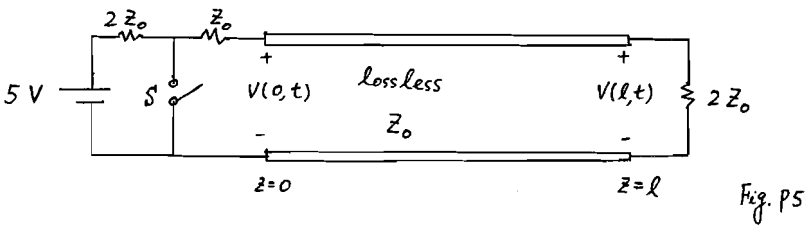


Fig. p5

國立台灣科技大學九十七學年度碩士班招生試題

系所組別：電子工程系碩士班乙三組、丙組

科　　目：電磁學

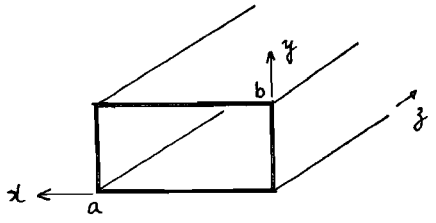
6. A TE_{10} wave propagates in an air-filled rectangular metallic waveguide axb with a > b. Assume that the waveguide is lossless and the electric field intensity in the waveguide is as follows

$$\vec{E}(x, y, z) = \hat{a}_y E_o \sin\left(\frac{\pi}{a} x\right) e^{-j\beta z} \quad (\text{volt / meter}).$$

Find

(a) the magnetic field intensity $\vec{H}(x, y, z)$. (5%)

(b) the average power $\vec{P}_{ave}$ in the waveguide. (5%)



$$\int_{x=0}^{a} \sin^2\left(\frac{\pi x}{a}\right) dx = \frac{a}{2}$$