

國立台灣科技大學一百學年度碩士班招生試題

系所組別：光電工程研究所碩士班

科目：電磁學

(總分為100分)

1. An electric field is represented by $\vec{E} = \hat{i} ay + \hat{j} ax$ (v/m), where $a = 10$ (v/m²),

Find:

- (a) the potential function V , taking $V = 0$ at the origin. (5%)
 (b) the work done by the field when a charge $q = 100$ (nC) is taken from $P_1(-1 \text{ (m)}, -3 \text{ (m)})$ to $P_2(3 \text{ (m)}, 2 \text{ (m)})$. (5%)

2. For the parallel-plate capacitor given in Fig. p2, suppose a volume density of charge

$$\rho_v = \rho_0 \sin\left(\frac{\pi z}{2d}\right) \text{ is added between the plates.}$$

Assuming negligible fringing effect at the edges, determine

- (a) the potential (V) at any point between the plates (8%)
 (b) the electric field ($\vec{E}$) at any point between the plates (6%)
 (c) the surface charge densities (ρ_s) on the plates ($z = 0, z = d$). (6%)

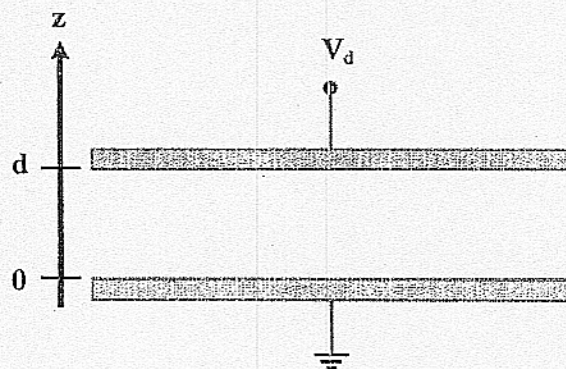


Figure p2.

3. Current I flows along the positive z -direction in the inner conductor of a long coaxial cable and returns through the outer conductor. The inner conductor has radius a , and the inner and outer radii of the outer conductor are b and c , respectively.

Determine the magnetic field intensity ($\vec{H}$) in each of the following regions:

- (a) $0 \leq r \leq a$, (5%)
 (b) $a \leq r \leq b$, (5%)
 (c) $b \leq r \leq c$, (5%)
 (d) $r \geq c$. (5%)



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4. (10%)

- a) Write down the Maxwell's equations (four equations) in the differential forms in terms of the vector fields $[\vec{E}(x,y,z,t), \vec{H}(x,y,z,t), \vec{D}(x,y,z,t), \vec{B}(x,y,z,t)]$ and sources $[\rho(x,y,z,t), \vec{J}(x,y,z,t)]$ in a simple medium. (4%)
- b) Write down the time-harmonic Maxwell's equations (four equations) in terms of the vector field phasors $[\vec{E}_p(x,y,z), \vec{H}_p(x,y,z)]$ and source phasors $[\rho_p(x,y,z), \vec{J}_p(x,y,z)]$ in a simple medium, where $\vec{E}(x,y,z,t) = \text{Re}[\vec{E}_p(x,y,z)e^{j\omega t}]$, $\vec{H}(x,y,z,t) = \text{Re}[\vec{H}_p(x,y,z)e^{j\omega t}]$, (4%)
- c) Write the homogeneous wave equation for the electric field. (2%)

5. (25%)

If the instantaneous expression of an electric field intensity in a lossless, simple

medium is given by $\vec{E}(x,y,z,t) = \hat{a}_z 10^{-4} \cos(2\pi 10^8 t - \frac{4\pi}{3} y)$ (V/m),

determine

- a) the polarization, (2%)
- b) the dielectric constant, (2%)
- c) conductivity, (2%)
- d) the direction of propagation, (2%)
- e) the intrinsic impedance, (3%)
- f) the wavelength, (2%)
- g) the propagation constant, (2%)
- h) the frequency, (2%)
- i) the instantaneous expression for the magnetic field intensity, (4%)
- j) the average power density of the wave. (4%)

6. (15%)

A signal generator having an internal resistance $5 (\Omega)$ and an open-circuit voltage $v_g(t) = 10 \cos(2\pi 10^9 t)$ (V) is connected to a $15 (\Omega)$ lossless transmission line. The line is 3 meter long and the velocity of wave propagation on the line is 2×10^8 (m/s). For the matched load, find

- a) the instantaneous expression for the voltage and current at an arbitrary location on the line, (7%)
- b) the average power transmitted to the load. (8%)

