

國立臺灣科技大學 110 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. (15%) Consider three fixed point charges are located in a rectangular coordinate system. Charge $Q_1 = +4 \mu\text{C}$ is located at (0 cm, 2 cm), charge $Q_2 = -3 \mu\text{C}$ is located at $(\sqrt{3} \text{ cm}, 1 \text{ cm})$, and charge $Q_3 = +5 \mu\text{C}$ is located at $(\sqrt{3} \text{ cm}, -1 \text{ cm})$. (The permittivity $(\epsilon_0) = \frac{1}{36\pi} \times 10^{-9} \text{ (F/m)}$)
- (a) Determine the electric field intensity at (0,0). (5%)
- (b) Determine the electric potential at (0,0). (5%)
- (c) If a 10 nC charge is located at (0,0), find the electric force exerted on the charge. (5%)
2. (15%) Figure P2 shows a capacitor consisting of two square parallel, conducting plates of side length w separated by a distance d . Charges $+Q$ and $-Q$ are placed on the plates, and the power supply is then removed. A solid dielectric slab of permittivity ϵ is inserted a distance x into the capacitor. Assume d is much smaller than x .
- (a) Determine the capacitance. (5%)
- (b) Determine the energy stored in the capacitor. (5%)
- (c) Find the force exerted by the plates on the solid dielectric slab. (5%)

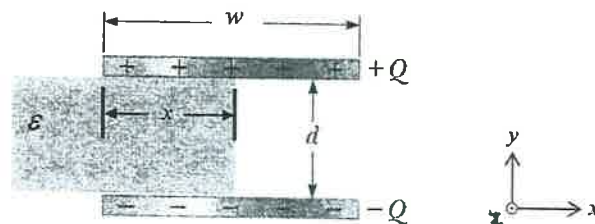


Figure P2.

3. (20%) A long, straight, non-magnetic conductor of $5 \times 10^{-4} \text{ m}$ radius carries a uniformly distributed current of 1 A dc. Assuming the current is $+z$ directed. ρ (in meter) is the radial distance measured from the z -axis, and the axis of the conductor is coincident with the z -axis. (The permeability $(\mu_0) = 4\pi \times 10^{-7} \text{ (H/m)}$)
- (a) Find the current density (\bar{J}) within the conductor. (3%)
- (b) Find the magnetic field intensity (\bar{H}) and the magnetic flux density (\bar{B}) within the conductor ($0 \leq \rho \leq 5 \times 10^{-4} \text{ m}$). (6%)
- (c) Find the magnetic field intensity (\bar{H}) and the magnetic flux density (\bar{B}) outside the conductor ($\rho > 5 \times 10^{-4} \text{ m}$). (6%)
- (d) Calculate $\nabla \times \bar{H}$ outside the conductor. (5%)



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4. (30%) The electric field of a uniform plane wave propagating in a dielectric medium is given by
$$\vec{E}(z, t) = \vec{a}_x 2 \cos(10^8 t - z/\sqrt{3}) \text{ (V/m).}$$

(a) Determine the phasor of the electric field. (5%)
(b) Determine the frequency, wavelength, state of polarization, and direction of propagation of the wave. (10%)
(c) Determine the instantaneous expression of the corresponding magnetic field of the wave. (8%)
(d) Determine the average power density of the wave. (7%)
5. (10%) In free space ($z \leq 0$), a plane wave with the magnetic field
$$\vec{H}_i = \vec{a}_x 10^{-2} \cos(10^8 t - \beta z) \text{ (A/m)}$$
 is incident normally on a lossless medium ($\epsilon = 2\epsilon_0, \mu = 8\mu_0$) in region $z \geq 0$.
(a) Determine the reflected electric field \vec{E}_r . (5%)
(b) Determine the transmitted electric field \vec{E}_t . (5%)
6. (10%) A distortionless line has the characteristic impedance $Z_0 = 60 \Omega$, the attenuation constant $\alpha = 0.04 \text{ Np/m}$, speed $= 0.6c$, where c is the speed of light in a vacuum. Find the line parameters R, L, G, C , and the wavelength at 100 MHz. (10%)

