國立臺灣科技大學 108 學年度碩士班招生試題

系所組別：電子工程系碩士班丙組

科　　目：電磁學

(總分為 100 分)

1. (20%) (a) The linear electric quadrupole is an arrangement of three charges as in the following Figure (a). Determine the potential V in terms of q, a, θ, r, and ε_0 at an arbitrary point P at a distance $r^3 >> a^3$ from the quadrupole? (10%)

   (b) The two-dimensional quadrupole is an arrangement of the point charge distribution shown in the following Figure (b). Determine the potential V in terms of q, a, θ, r, and ε_0 at an arbitrary point P at a distance $r^3 >> a^3$ from the two-dimensional quadrupole? (10%)
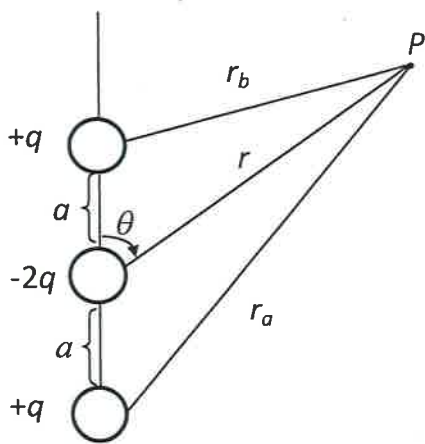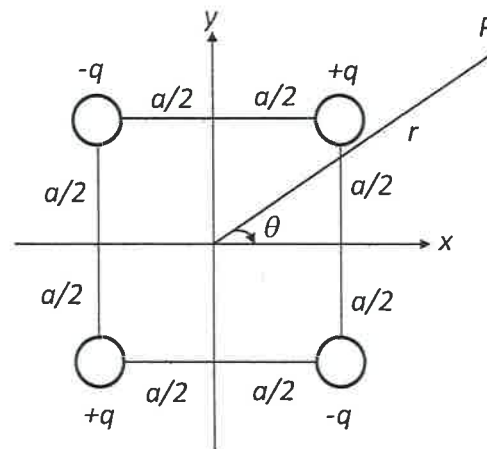

Figure (a): Electrical Quadrupole

Figure (b): Two-dimensional Quadrupole

2. (10%) A square capacitor with an edge of a, shown in the following Figure, consists of two conducting square plates to form a wedge-shaped configuration with a small angel of θ. Determine the capacitance of this capacitor in terms of a, θ, d, and ε_0? (10%)
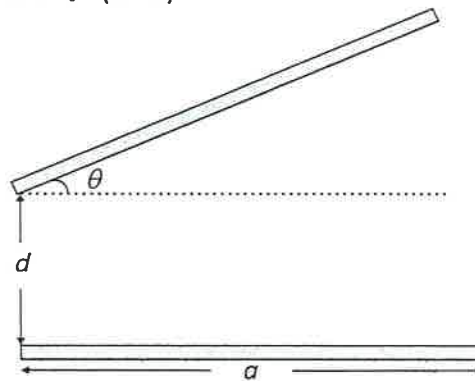

Figure: A Square Capacitor

3. (20%) (a) A finite line charge of length $2L$ carrying uniform line charge density ρ is coincident with the x-axis, shown in the following Figure (a). Determine the electric field intensity at a point P? (10%)

   (b) A direct current I flows in a straight wire of length $2L$ shown in the following Figure (b). Determine the magnetic flux density B through the vector magnetic potential at a point P located at a distance r from the wire in the bisecting plane? (10%)
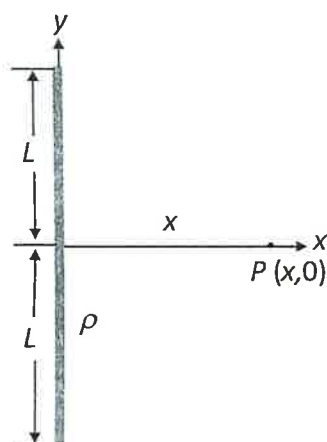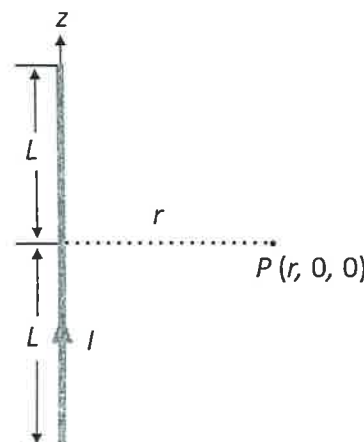

Figure (a): A Finite Line Charge

Figure (b): A Current-carrying Straight Wire

(總分為 100 分)

4. (25%) In a lossless dielectric, for which its intrinsic impedance $\eta = 60\pi$, relative permeability $\mu_r = 1$, a magnetic field intensity, where the permittivity of free space $\epsilon_0 = \left(\frac{1}{36\pi}\right) \times 10^{-9}$ F/m and permeability $\mu_0 = 4\pi \times 10^{-7}$ (H/m)

$$\bar{H} = -0.1\cos(\omega t - z)\,\bar{a}_x + 0.5\sin(\omega t - z)\bar{a}_y \ (A/m)$$

(a) Find its angular frequency ω and relative permittivity ϵ_r (10%)

(b) Find its corresponding electric field $\bar{E}$. (15%)

5. (12%) A uniform electromagnetic plane wave propagates in seawater with frequency $f = 5MHz$. The constitutive parameters of seawater are relative permittivity $\epsilon_r = 72$, relative permeability $\mu_r = 1$, and conductivity $\sigma = 4$ (S/m).

Find its attenuation constant, phase constant, intrinsic impedance, phase velocity, wavelength, and skin depth. (2% each)

6. (13%)

A conducting bar slide freely over two conducting rails as shown in the following figure. Calculate the induced voltage in the bar(between P and Q).

(a) If the bar slides at a velocity $\bar{u} = 20\bar{a}_y \ m/s$ and the magnetic flux density $\bar{B} = 4 \times 10^{-3}\bar{a}_z \ (Wb/m^2)$ (7%)

(b) If the bar is stationed at $y = 8cm$ and the magnetic flux density $\bar{B} = 4 \times 10^{-3}\cos(10^6 t)\,\bar{a}_z \ (Wb/m^2)$ (6%)