國立台灣科技大學九十五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 100 分

1. A spherical distribution of charge is

$$\rho = \rho_0\left(1+\frac{r^2}{a^2}\right), \quad (r \le a)$$

$$\rho = 0 \qquad\qquad (r > a).$$

(a) Calculate the total charge Q. (3%)

(b) Find the electric field intensity and the potential outside the charge distribution. (5%)

(c) Find the electric field intensity and the potential inside the charge distribution. (7%)

2. (a) Determine the electric field intensity in free space of an infinitely long, straight, line charge of a uniform density ρ_l. (5%)

(b) With reference to Fig. 2, use the image method to find the capacitance per unit length of an infinitely long, straight, conducting cylinder of radius r with its center a distance d from a parallel conducting plane. (10%)

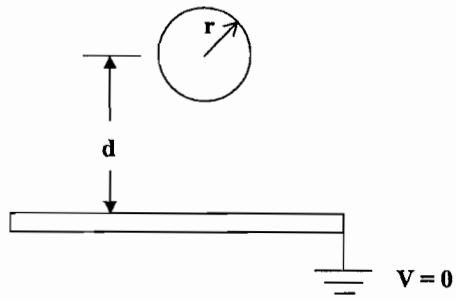

Figure 2

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3. (a) A direct current I flows in a linear conductor P_1P_2. Show that the magnetic flux density at an arbitrary point P due to the linear conductor defined by the geometry shown in Fig. 3(a) is

$$\vec{B}=\frac{\mu I}{4\pi r}(\sin\alpha - \sin\beta)\hat{a}_\varphi \quad (10\%)$$

(b) A square loop of side lengths $2l$ lies in the xy plane and is centered at the origin. The square loop carries a current I that circulates in the clockwise direction (Fig. 3(b)). Find the magnetic flux density at point $A(\frac{l}{2},\frac{l}{2})$. (10%)

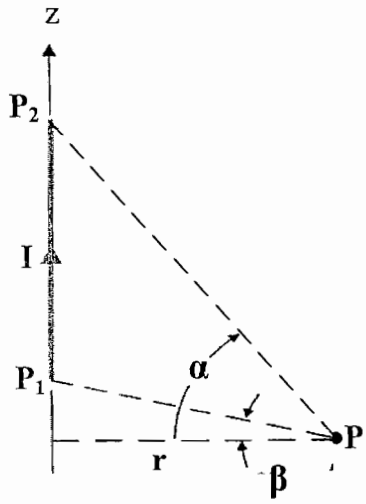

Figure 3(a)

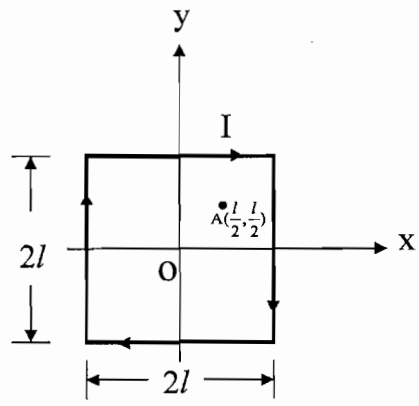

Figure 3(b)

4. In a source-free **conducting** media with constitutive parameters ε, μ and σ, please derive the wave equation governing the $\vec{E}$ field based on Maxwell's equations. (10%) (hint: find $\nabla^2\vec{E}$)

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5. Prove that an elliptically polarized wave could be decomposed into
   (a) Two circularly polarized waves. (5%)
   (b) One linearly polarized wave and one circularly polarized wave. (5%)

6. The electric field intensity of a linearly polarized uniform plane wave propagating in the +z-direction (for (a)(b)(c) cases) in seawater is $\bar{E}=\hat{a}_x 50\cos(4\times10^7\pi t)$(V/m) at z = 0. The constitutive parameters of seawater are $\varepsilon_r = 80$, $\mu_r = 1$ and $\sigma = 4$ (S/m)
   (a) Determine the intrinsic impedance η_c. (5%)
   (b) Find the distance at which the amplitude of E is 4% of its value at z = 0. (5%)
   (c) Write the expressions for $\bar{E}(z, t)$ at z = 0.4 (m) as a function of t. (5%)
   (d) Find the Brewster angle θ_{BII} if it is an oblique incidence of plane wave at the air-seawater boundary. (5%)

7. Prove that a maximum power is transferred from a voltage source with an internal impedance Z_g to a load impedance Z_L over a lossless transmission line when $Z_i = Z_g^*$, where Z_i is the impedance looking into the loaded line. (10%)