國立臺灣科技大學101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

（總分為100分）

1. In spherical coordinates, prove

(a) $\dfrac{\partial \hat{r}}{\partial \theta} = \hat{\theta}$ (5%)

(b) $\dfrac{\partial \hat{r}}{\partial \varphi} = \hat{\varphi} \sin \theta$ (5%)

(c) $\nabla \bullet \vec{A} = \dfrac{1}{r^2}\dfrac{\partial}{\partial r}\left(r^2 A_r\right) + \dfrac{1}{r \sin\theta}\dfrac{\partial}{\partial \theta}\left(A_\theta \sin\theta\right) + \dfrac{1}{r \sin\theta}\dfrac{\partial A_\varphi}{\partial \varphi}$ (10%)

[Hint: $\nabla = \hat{r}\dfrac{\partial}{\partial r} + \dfrac{\hat{\theta}}{r}\dfrac{\partial}{\partial \theta} + \dfrac{\hat{\varphi}}{r \sin\theta}\dfrac{\partial}{\partial \varphi}$ and $\vec{A} = \hat{r}A_r + \hat{\theta}A_\theta + \hat{\varphi}A_\varphi$]

2. (a) An electric dipole consisting of equal and opposite point charges +Q and -Q separated by a small distance s is shown in **Fig. 1**. Determine the potential V in terms of Q, s, θ, r and ε_0 at an arbitrary point P at a distance $r^3 >> s^3$ from the dipole? (10%)

(b) The linear electric quadrupole is an arrangement of three charges as in **Fig. 2**. Determine the potential V in terms of Q, s, θ, r and ε_0 at an arbitrary point P at a distance $r^3 >> s^3$ from the quadrupole? (10%)

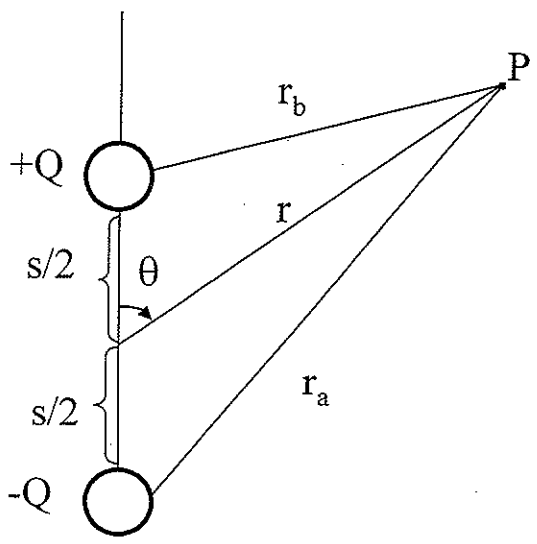

Fig. 1 Electrical Dipole

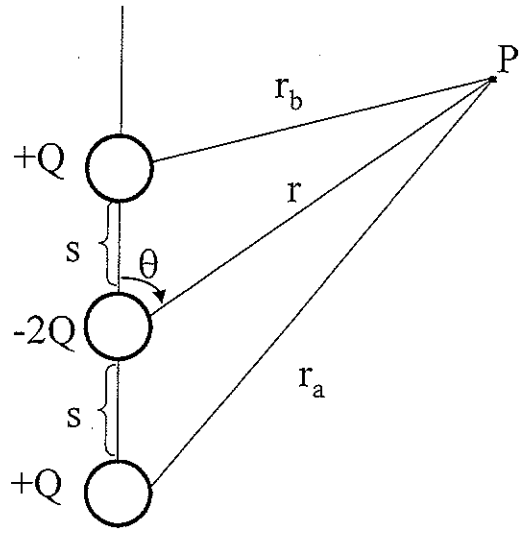

Fig. 2 Electrical Quadrupole

3. Obtain a formula for the electric field intensity on the axis of a circular disk of radius b that carries a uniform surface charge density ρ_S, as shown in **Fig. 3**? (10%)

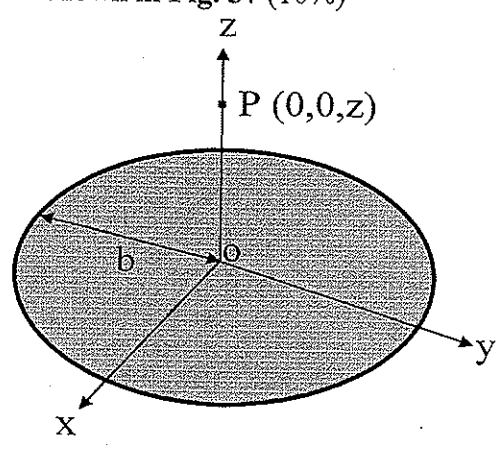

Fig. 3 A Uniformly Charged Disk

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4. Consider the transmission line circuit shown in Fig. 4. Assume that the switch is closed at t=0. Please calculate the load voltage v_C when t=∞. (10 %)

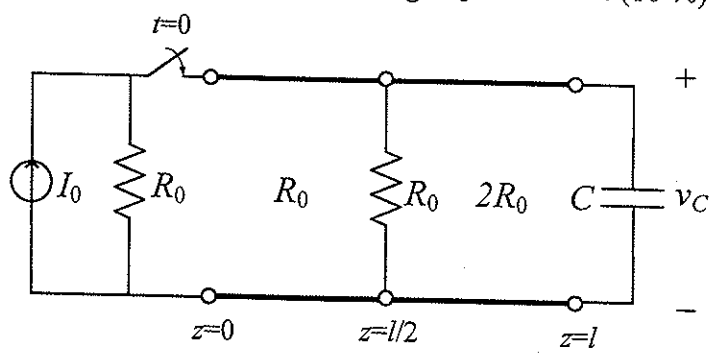

Fig. 4

5. Consider the transmission line circuit shown in Fig. 5. Please write down the expressions for (a) the input impedance Z_A (5 %) and (b) the input impedance Z_B (5 %). (c) Please derive the resonance condition in terms of Z_h, Z_l, θ_h, and θ_l when the two sub-circuits are connected together. (10 %).

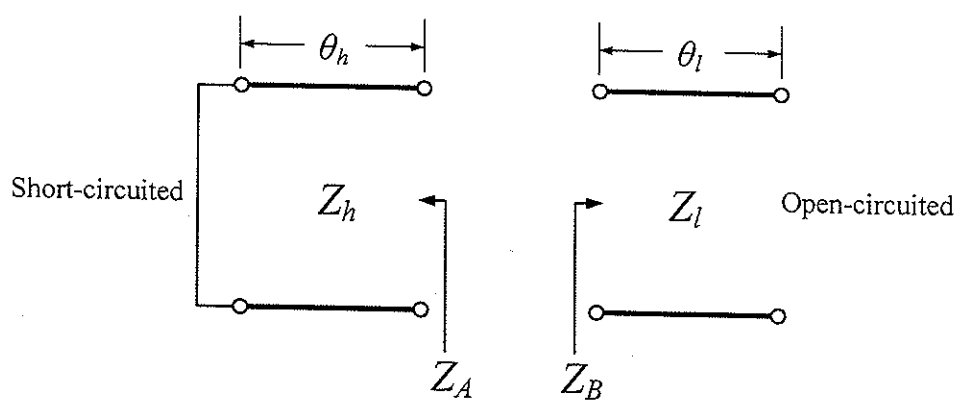

Fig. 5

6. Consider the rectangular waveguide circuit shown in Fig. 6. (a) Please calculate in ascending order the cutoff frequencies of the first two modes in waveguide 1 (8%). (b) Please calculate in ascending order the cutoff frequencies of the first two modes in waveguide 2 (8%). (c) Please identify the frequency range that ensures TE_{10} mode propagation without higher order modes. (4 %).

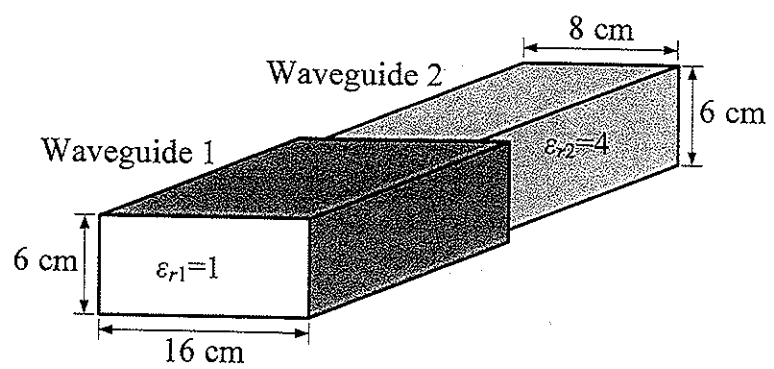

Fig. 6