國立臺灣科技大學 104 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. Determine the E field (radius R) inside a spherical cloud of electrons (radius b) with a uniform volume charge density $\rho = -\rho_0$ (where ρ_0 is a positive quantity) for $0 \leqq R \leqq b$ and $\rho = 0$ for $R > b$ by solving Poisson's equation for V. (10%)

2. (a) An electric dipole consisting of equal and opposite point charges +q and -q separated by a small distance d is shown in **Fig. 1**. The distances from the charges to a field point P are designed R_+ and R_-. The distance from the dipole center to a field point P is assumed as R. θ denotes the angle between the z axis and R. Determine the potential V in terms of q, d, θ, R and ε_0, permittivity of free space, at an arbitrary point P at a distance $R >> d$ from the dipole? (10%)
(b) Derive the equation to represent the equipotential lines for an electric dipole? (5%)
(c) Derive the equation to represent the electric field lines for an electric dipole? (5%)

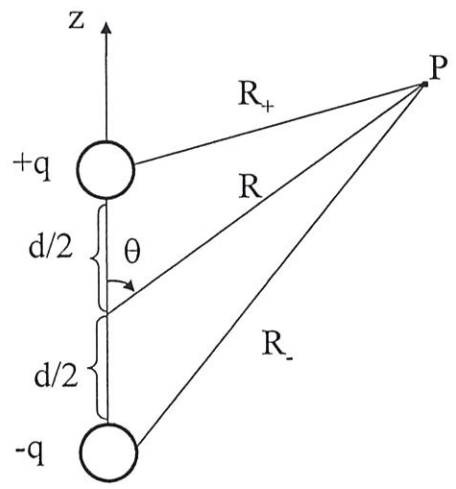

Fig. 1 An electrical dipole

3. (a) A direct current *I* flows in a straight wire of length 2*L* on the z axis, as shown in **Fig. 2**. Find the magnetic flux density B at a point located at a distance *r*, designed (*r*,0,0) in cylindrical coordinates, from the wire in the bisecting plane. (10%)
(b) Find the magnetic flux density at the center of a square loop, O, on the z axis and with side w carrying a direct current *I*, as shown in **Fig. 3**. (10%)

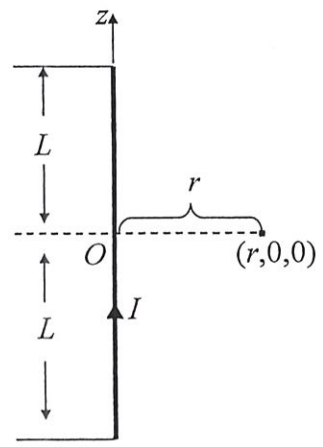

Fig. 2 A current-carrying straight wire.

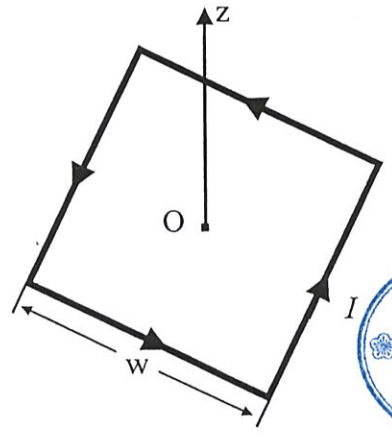

Fig. 3 A square loop carrying current *I*

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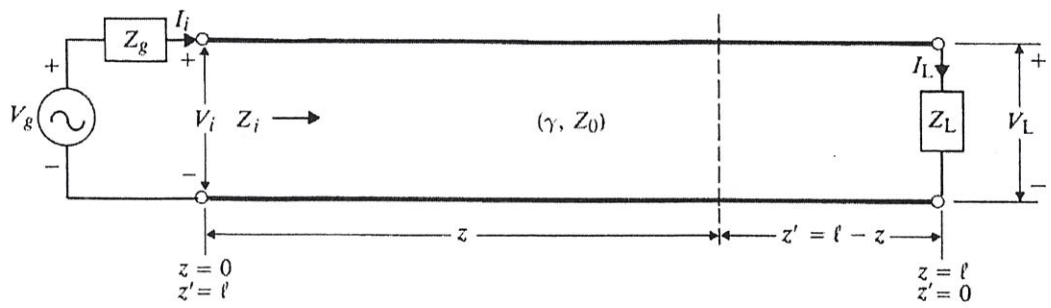
4. (a) Please write down the four Maxwell equations in phasor form. (10%) (b) Under what criterion will the four Maxwell equations be simplified to the electrostatic and magnetostatic fields? (5%) (c) Please write down the equations for the electrostatic and magnetostatic fields. (5%)

5. Consider the transmission line circuit shown below. (a) What should the per-unit length parameters of the transmission line satisfy that will make the transmission line distortionless? (5%) (b) Please write down the attenuation and propagation constants in terms the per-unit-length parameters of the transmission line when the transmission line is distortionless. (5%)



6. Consider a line current $I\cos(\omega t)$ shown below. The line current is of one quarter of a circle and falls on the xy-plane (z=0 plane). Besides, the line current is placed between two infinitely conducting wall, extending in the $\pm z$-axis. Please calculate the far-fields at point P, which is placed at a distance R from the origin O and falls on the xy-plane. (20%) Hint: the potential vector A of a current loop I is $A = a_\phi \frac{\mu_0 I b^2}{4R^2}(1 + j\beta R)e^{-j\beta R}\sin\theta$ where θ is the angle from the z-axis.