國立臺北科技大學九十六學年度碩士班招生考試

系所組別：1730 電腦與通訊研究所丙組

第二節 電磁學 試題

注意事項：

1.本試題共五題，配分共 100 分。
2.請標明大題、子題編號作答，不必抄題。
3.全部答案均須在答案卷之答案欄內作答，否則不予計分。

(請依序作答，作答與未作答之題號均請依序抄寫。)

一、 Consider an electric dipole consisting of charges $+q$ and $-q$ positioned at z = $+d/2$ and z = $-d/2$ on the z-axis, respectively. The distances from the charges to a field point P (R, θ, φ) are designated R_+ and R_-. Please show that the free-space electrostatic potential V at point P in the far-field region with $d << R$ is $V = \frac{qd\cos\theta}{4\pi\varepsilon_0 R^2}$. (20%)

二、 Consider a line charge ρ_ℓ (C/m) located at a distance d from the axis of a parallel, conducting, circular cylinder of radius a. Both the line charge and the conducting cylinder are assumed to be infinitely long. The cylindrical conducting surface can be replaced by an image line charge $\rho_i = -\rho_\ell$ on the plane containing both ρ_ℓ and the center axis of the conducting cylinder. The electrostatic potential V at any point on and outside the surface can then be determined from the original line charge ρ_ℓ and the image line charge ρ_i. Please show that the image line charge $\rho_i = -\rho_\ell$ is located at the distance $d_i = \frac{a^2}{d}$ away from the axis of the conducting cylinder. (20%).

三、 Please derive the time-domain equation of continuity $\nabla \bullet \vec{J} = -\frac{\partial \rho}{\partial t}$ with the aid of the principle of conservation of charge. (20%)

四、 Please show that the skin depth δ of a good conductor with $\sigma/(\omega\varepsilon) >> 1$ is given as $\delta = \sqrt{\frac{2}{\omega\mu\sigma}}$ or $\delta = \frac{1}{\sqrt{\pi f\mu\sigma}}$, through which the amplitude of a traveling plane wave decreases by a factor of e^{-1}. (20%)

五、 Please show that the characteristic impedance, Z_0, and phase constant β of a lossless transmission line can be determined as $Z_0 = \sqrt{Z_{is}Z_{io}}$ and $\beta = \frac{1}{\ell}\tan^{-1}\sqrt{-(Z_{is}/Z_{io})}$ where Z_{is} is the input impedance of the lossless transmission line section of length ℓ under short-circuit condition and Z_{io} that of the same transmission line section under open-circuit condition. (20%)