

國立臺灣科技大學102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

(總分為100分)

1. (10%) An infinitely long straight solid metal rod has a radius of R and a charge per unit length of λ C/m. Find the electric field at (a) r_1 , where $0 < r_1 < R$ (5%), (b) r_2 , where $r_2 > R$ (5%). r_1 and r_2 are distances measured perpendicular to the rod's axis.
2. (20%) A thin disk of radius R has a uniform charge density σ . The disk is rotating as a rigid object with angular speed ω about an axis that is perpendicular through its center. Find the magnetic field at the center of the disk.
3. (20%) An electric dipole is composed of two charges, a positive and a negative charge of the same magnitude separated by a distance s as shown in Fig. 1. (a) Find the electric dipole moment (5%). If $r \gg s$, the electric potential at point P due to the electric dipole is $V = \frac{Qs}{4\pi\epsilon_0 r^2} \cos\theta$, (b) find the spherical coordinate components E_r , E_θ and E_ϕ of the electric field at point P (15%).

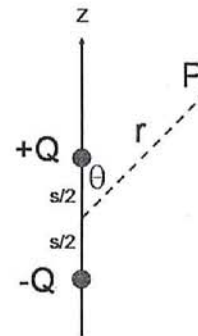


Fig. 1



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4. (10%) Consider a magnetic field which increases exponentially with time,

$$\vec{B} = B_0 e^{\frac{1}{2}t} \hat{a}_z \text{ (T)},$$

where B_0 is a constant. Find the electric field (\vec{E}) produced by this magnetic field.

5. (20%) The electric-field phasor of a uniform plane wave traveling downward in water is given by

$$\tilde{E} = 9e^{-0.5z} e^{-j0.5z} \hat{a}_x \text{ (V/m)},$$

where \hat{a}_z is the downward direction and $z = 0$ is the water surface. If $\sigma = 10 \text{ S/m}$,

- Obtain an expression for the average power density. (8%)
 - Determine the attenuation rate. (7%)
 - Determine the depth at which the power density has been reduced by 50 dB. (5%)
($\ln 10 = 2.3$)
6. (20%) A 50 MHz voltage source drives the series combination of an impedance, $Z_g = 20 + j 30 \Omega$ and a lossless transmission line of length $\lambda/4$, terminated by a load impedance, Z_L . The line characteristic impedance is 100Ω .
- Determine the load impedance value required to achieve a net impedance (seen by the voltage source) of 60Ω . (10%)
 - If the inductance of the line is $L = 5 \mu\text{H/m}$, determine the line length. (10%)

