

國立臺灣科技大學103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. A coaxial cable is composed of an inner solid cylindrical conductor of radius a and a cylindrical shell of negligible thickness with radius b where $b > a$. The spacing between the conductor and the outer shell is filled with a material with a dielectric constant κ . Find the capacitance per unit length of this cable (10%).

2. Fig. 1 shows a rectangular loop carrying current I_2 is placed close to a straight infinitely long conductor carrying current I_1 . (a) Find the magnetic flux that goes through the loop (10%). (b) Obtain an expression for the magnetic force experienced by the loop (10%).

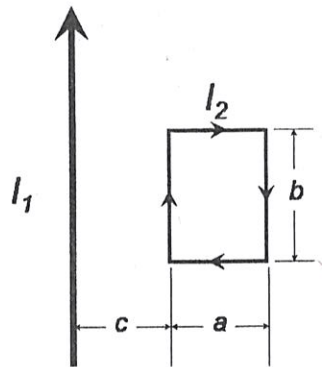
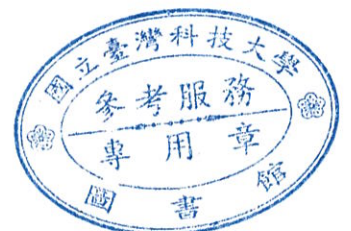


Fig. 1

3. An infinitely long insulating cylinder of radius R has a volume charge density that varies with the radius as: $\rho = \rho_0 \left(a - \frac{r}{b} \right)$ where ρ_0 , a and b are positive constants and r is the distance from the axis of the cylinder. Find the magnitude of the electric field at radial distances (a) $r < R$ (10%) and (b) $r > R$ (10%).



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4. A submerged isotropic light source is at a distance of 3 m below the water surface. Find the surface area of light seen on the surface. The relative permittivity of water at optical frequencies is 1.75 (8%).
5. A lossless transmission line having the characteristic impedance $Z_0 = 125 \Omega$ is operating at $\omega = 4.5 \times 10^8$ rad/s. If the velocity on the line is 2.5×10^8 m/s, determine:
- (a) The inductance per unit length in $\mu\text{H}/\text{m}$ (8%).
 - (b) The capacitance per unit length in pF/m (8%).
- If the lossless transmission line is terminated with a load Z_L , which consists of a $0.8 \mu\text{H}$ inductor in series with a 105Ω resistor, determine:
- (c) The reflection coefficient (Γ) (10%).
 - (d) The voltage standing-wave ratio (S) (8%).
6. A symmetric slab waveguide is designed to support only a single pair of TE and TM modes at wavelength $\lambda = 1.6 \mu\text{m}$. The slab thickness is to be $4.0 \mu\text{m}$, and the refractive index of the surrounding material is 3.5. Please find the maximum value of the refractive index of the slab waveguide (8%).

