

國立臺北科技大學 101 學年度碩士班招生考試

系所組別：2401、2402、2403、2404 光電工程系碩士班

第二節 電磁學 試題

第一頁 共一頁

注意事項：

1. 本試題共六題，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。

1. When a spacecraft reenters the earth's atmosphere, its speed and temperature ionize the surrounding atoms (molecules) and generate plasma. The electron density (N) in the neighborhood is $4 \times 10^8 \text{ cm}^{-3}$. If the value of e , m , and ϵ_0 are $1.602 \times 10^{-19} \text{ (C)}$, $9.107 \times 10^{-31} \text{ (kg)}$, and $(1/36\pi) \times 10^{-19} \text{ (F/m)}$.
 - (1) Find the plasma frequency (f_p). (5%)
 - (2) What the frequency (f) is must usage in radio communication between the spacecraft and the mission controllers on earth. (5%)
2. A positive point charge Q is at the center of a spherical dielectric shell of an inner radius R_i and an outer radius R_o . The dielectric constant of the shell is ϵ_r . Find the electric field E , the potential V , the electric displacement D , and the polarization P in three regions:
 - (1) $R > R_o$, (10%)
 - (2) $R_i < R < R_o$, (10%)
 - (3) $R < R_i$, (10%)
3. A conducting material of uniform thickness h and conductivity σ has the shape of a quarter of a flat circular washer, with inner radius a and outer radius b , as shown in Fig. 3. We first assume a potential difference V_0 between the end faces, say $V = 0$ on the end face at $y = 0$ and $V = V_0$ on the end face at $x = 0$. Determine the resistance (R) between the end faces. (10%)

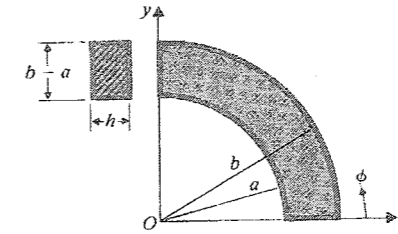


Fig. 3

4. A cladded-core optical fiber shows in Fig. 4, where $n_1 > n_2$ and $n_0 = 1$.
 - (1) Derive and express the maximum angle of incidence (θ_a) and the numerical aperture (NA) in terms of n_0 , n_1 , and n_2 for meridional rays incident on the core's end face to be trapped inside the core by total internal reflection. (10%)
 - (2) Find θ_a and NA . If $n_1 = 1.50$, $n_2 = 1.48$. (5%)

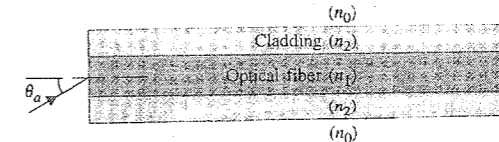


Fig. 4

5. An air-filled rectangular waveguide of inside dimensions 7 cm x 3.5 cm operates in the dominant TE_{10} mode as shown in Fig. 5. The waves are propagating in the z direction.
 - (1) Find the cutoff frequency (f_c). (5%)
 - (2) Determine the phase velocity (v_g) of the wave in the guide at a frequency of 5.0 GHz (5%).
 - (3) Determine the guided wavelength (λ_g) at the same frequency. (5%)

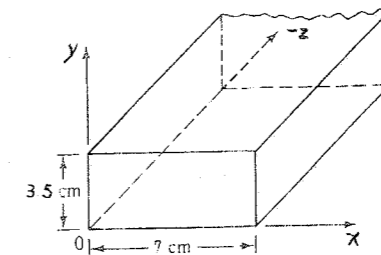


Fig. 5

6. An isolated system consists of three very long parallel conducting wires (ℓ_0 , ℓ_1 , ℓ_2). The axes of all three wires lie in a plane. The two outside wires (ℓ_0 , ℓ_2) are of a radius b and both are at a distance $d = 500b$ from a center wire (ℓ_1) of a radius $2b$. Determine the partial capacitance per unit length (C_{12} , C_{10} , C_{20}). (20%)