

國立清華大學 102 學年度碩士班考試入學試題

聯合招生(工科丙組、先進光源工科組)

系所班組別：工程與系統科學系碩士班 丙組

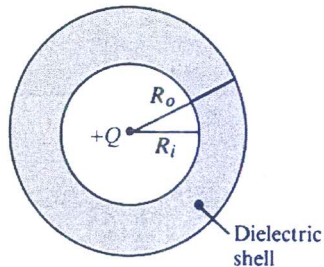
先進光學科技碩士學位學程 工程與系統科學組

考試科目 (代碼)：電磁學 (9803)

共 3 頁，第 1 頁 *請在【答案卷、卡】作答

1. (20%). 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 of following figure. The dielectric constant of the shell is ϵ_r . Determine all \vec{E} , V , \vec{D} and \vec{P} as functions of the radial distance R .

- (A). $R > R_o$ (5%)
(B). $R_i < R < R_o$ (10%)
(C). $R < R_i$ (5%)



2. (10%) Answer the following questions and justify your answers.

Suppose that in Coulomb's law the strength of the electrical field is inverse- r^3 law proportion to distance ($E \propto \frac{1}{r^3}$).

- (A). Is the field still conservative? (5%)
(B). Is Gauss's law still valid? (5%)

3. (10%). According to following figures

- (A). Draw the electric field lines of an electric dipole. (5%)
(B). Draw the magnetic flux lines of a magnetic dipole. (5%)

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(A) Electric dipole

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(B) Magnetic dipole

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4. (20%) A narrow-band signal propagates in a lossy dielectric medium which has a loss tangent 0.2 at 550 (kHz), the carrier frequency of the signal. The dielectric constant of the medium is 2.5, and $\mu = \mu_0$.

$$c = 3 \times 10^8 \text{ (m/s)}, \quad \epsilon_0 = \frac{1}{36\pi} \times 10^{-9} \text{ (F/m)}, \text{ and } \mu = \mu_0 = 4\pi \times 10^{-7} \text{ (H/m)}$$

(A). Determine α (attenuation constant) and β (phase constant). (10%)

(B). Determine the phase velocity u_p and the group velocity u_g . (10%)

5. (15%) The electrical field intensity of a linearly polarized uniform plane wave propagation in the +z-direction in seawater is

$$\vec{E} = \hat{a}_x 100 \cos(10^7 \pi \cdot t) \text{ (V/m) at } z = 0.$$

The constitutive parameters of seawater are $\epsilon_r = 72$, $\mu_r = 1$ and $\sigma = 4 \text{ (S/m)}$.

$$c = 3 \times 10^8 \text{ (m/s)}, \quad \epsilon_0 = \frac{1}{36\pi} \times 10^{-9} \text{ (F/m)}, \text{ and } \mu_0 = 4\pi \times 10^{-7} \text{ (H/m)}$$

(A). Show the seawater can be approximated as “good conductor”. (5%)

(B). Determine the skin depth δ . (5%)

(C). Determine the phase velocity u_p . (5%)

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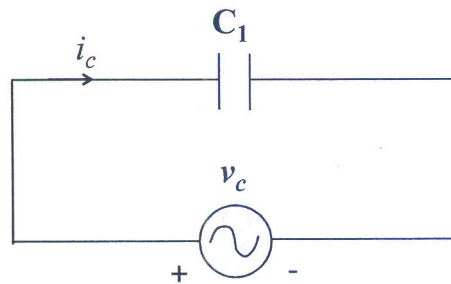
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共 3 頁，第 3 頁 *請在【答案卷、卡】作答

6. (10%) An a-c voltage source of amplitude V_0 and angular frequency ω , $v_c = V_0 \times \sin \omega t$, is connected across a parallel-plate capacitor C_1 in following figure.

(A). Verify that the displacement current (i_c) in the capacitor is the same as the conduction current in the wires. (5%)

(B). Determine the magnetic field intensity at a distance r from the wire. (5%)



7. (15%) For a rectangular waveguide in following figure, with its rectangular cross section of sides a and b . The enclosed dielectric medium is assumed to have constitutive parameters ϵ and μ . For TM waves, $H_z=0$ and E_z can be expressed as

$$E_z(x, y, z) = E_z^0(x, y) \cdot e^{-\gamma z}$$

(A). Determine the $E_z^0(x, y)$ (10%)

(B). Determine the TM_{mn} mode cutoff frequency $(f_c)_{mn}$. (5%)

