編號： 47

國立成功大學 106 學年度碩士班招生考試試題

系　　所：光電科學與工程學系

考試科目：電磁學　　考試日期：0214，節次：2

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A capacitor as shown in Fig.1 consists of two concentric spherical conductor shells of radii *a* and *b*. In between the shells is filled with dielectric I of relative permittivity ε_1 (left half-shell) and dielectric II of relative permittivity ε_2 (right half-shell). The inner and outer conductor shells are uniformly charged by +Q and –Q, respectively. Find the electric field $\vec{E}$ = _____, displacement $\overrightarrow{D_I}$ =_____, and $\overrightarrow{D_{II}}$ = in region I and II. The capacitance C= _____of the capacitor. (12 %)

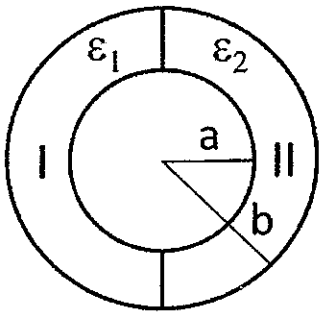

Fig. 1

2. A point charge +Q is located between two perpendicular conducting half-planes as shown in Fig.2. The coordinate of +Q is (*x*, *y*)=(a, 2a). The electric potential V of point P at coordinate (2a, a)= _____, and the force $\vec{F}$= _____ on the point charge +Q caused by the charges induced on the planes. (10 %)

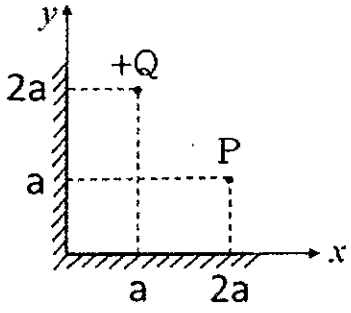

Fig. 2

3. Decide whether it is "true" or "false" in the following statements and give reasons. (12 %)
   (a) In a dielectric medium, the direction of induced polarization vector is always parallel to that of the electric field intensity.
   (b) A potential function satisfies Laplace's equation in a given region possesses no maximum or minimum values in this region.
   (c) Both static magnetic fields and time-varying magnetic fields can not exist in the interior of perfect conductor.

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4. Determine the mutual inductance between a very long straight wire and a conducting circular loop, as shown in Figure 3. (5%) (A) $L = \mu_0(d - \sqrt{b^2 - d^2})$ (B) $L = \mu_0(d - \sqrt{d^2 - b^2})$ (C) $L = \mu_0(d + \sqrt{b^2 - d^2})$ (D) $L = \mu_0(b - \sqrt{b^2 - d^2})$

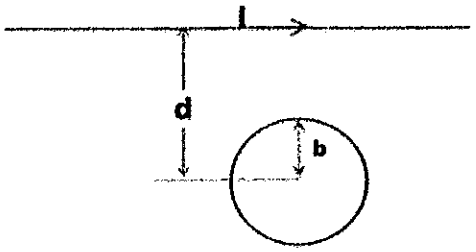

Fig. 3

5. Two identical coaxial coils, each of N turns and radius b, are separated by a distance d as shown in Fig.4. The current I_1 and I_2 for the left and right coils are in the same direction. (a) Find the magnetic flux density $\vec{B} = B_x\hat{x}$ along the x axis from x=0 to x=d. (6 %) (b) If I_1 =I_2=I, find the relation between b and d such that d^2B_x/dx^2 vanishes at the midpoint. (5 %)

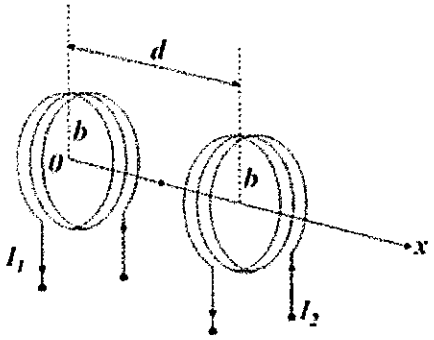

Fig. 4

6. An air-filled parallel-plate conducting waveguide has a plate separation of 1.25 cm. (25%)
   (a) Find the cutoff frequencies of TE_0, TM_0, TE_1, TM_1, and TM_2 modes.
   (b) Find the phase velocities of the above modes at 15 GHz.
   (c) Find the lowest-order TE and TM mode that cannot propagate in this waveguide at 25 GHz.

7. A plane wave at a wavelength of 1000 nm is linearly polarized at an angle θ with respect to the x-axis in air and propagates along the z-direction, as shown in Fig. 5. A dielectric with thickness L is placed in the path of wave propagation, which is characterized with a refractive index of 1.55 along the x-axis and a refractive index of 1.54 along the y-axis. Note that the propagation constant $k = wn/c$ in a lossless medium, where n is the refractive index and c is the speed of light. (25%)
   (a) If the plane wave becomes circularly polarized after passing through the dielectric, determine the

angle θ and the thickness L.

(b) If the plane wave is still linearly polarized after passing through the dielectric but with its polarization direction perpendicular to that of the incident wave, determine the angle θ and the thickness L.

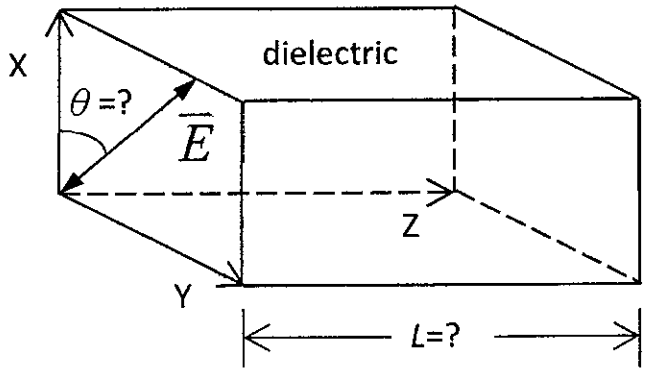

Fig. 5