

## 國立臺灣科技大學 109 學年度碩士班招生試題

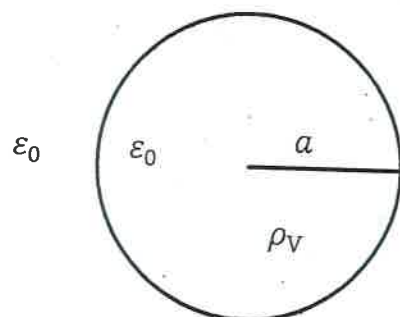
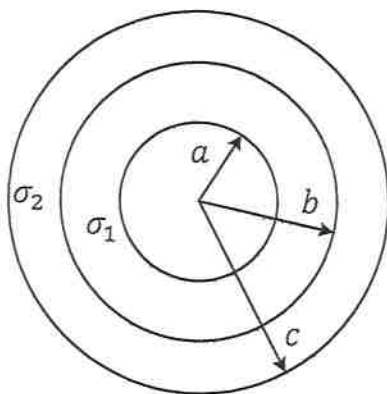
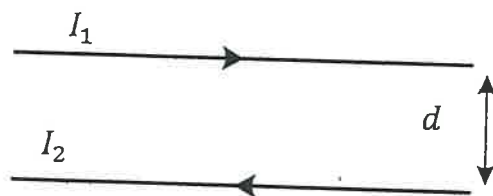
系所組別：電子工程系碩士班丙組

科目：電磁學

(總分為 100 分)

## 1 Terms definition and explanation

- (1) Please define a vector field which is conservative. (5%)  
 (2) Please write down the differential form of **Ohm's law**. (5%)  
 (3) Please write down the differential form of **Joule's law**. (5%)

2 Determine the **electric field** caused by a spherical distribution of a cloud of electrons with a uniform volume (1) charge density  $\rho_V$  for  $0 \leq R \leq a$  (8%); and (2) charge density zero for  $R > a$ . (7%)3 A spherical conductor of radius  $a$  is inside a spherical conducting shell of radius  $c$ . Two materials with conductivities  $\sigma_1$  and  $\sigma_2$  are used to fill the space between these conductors as shown in the below Figure. Please find the **resistance** between the inner and outer conductor. (10%)4 Find the **force per unit length** between two infinitely long parallel conducting wires carrying currents  $I_1$  and  $I_2$  in the opposite direction. The wires are separated by a distance  $d$ . (10%)

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5. Light can be treated as an electromagnetic wave. Consider a plane wave of infrared light which has a wavelength of  $\lambda_0 = 1.5 \times 10^{-6} \text{ m}$  when it propagates in the free space. Answer the following questions.

- (1). what is the frequency  $f$  (in Hz) of this electromagnetic wave when it propagates in the free space? (4%)
- (2). What is the propagation constant (i.e. phase constant)  $\beta$  (rad/m) of this electromagnetic wave when it propagates in the free space? (4%)
- (3). assume this electromagnetic wave enters a dielectric medium with a relative permittivity (i.e. dielectric constant)  $\epsilon_r = 4$  and a relative permeability  $\mu_r = 1$ . What are the
  - (a). frequency  $f$  (in Hz) (4%),
  - (b). wavelength (4%)
  - (c). phase velocity (4%)of this electromagnetic wave when it propagates in this dielectric medium?

6. The magnetic field of a uniform plane wave in free space is given by:

$$\vec{H} = H_0 \cos(6\pi \times 10^8 t + 2\pi y) \hat{x}$$

- (1). what is the direction of propagation of the wave? (3%)
- (2). what is the direction of the magnetic field at  $t = 0, y = 0$  ? (3%)
- (3). what is the direction of the electric field at  $t = 0, y = 0$  ? (3%)
- (4). what is the direction of the Poynting vector? (3%)
- (5). what is the direction of the magnetic field at  $t = 0, y = 0.5$  ? (3%)

7. Given that the skin depth for graphite at 100 (MHz) is 0.16 (mm), answer the following questions.

- (1). what is the meaning of "skin depth"? (5%)
- (2). determine the conductivity of graphite (5%),
- (3). determine the distance that a 1 (GHz) wave travels in graphite such that its field intensity is reduced by 30 (dB) (5%)

