

國立中央大學101學年度碩士班考試入學試題卷

所別：機械工程學系光機電工程碩士班 乙組(光機)一般生

科目：電磁學

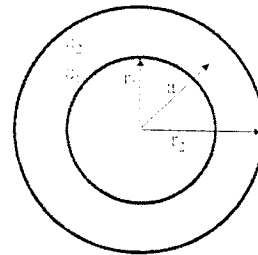
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\*請在試卷答案卷(六)內作答

1. What is Stokes's theorem? Proof Stokes's theorem by any vector and space. (8%)
2. What is divergence theorem? Proof divergence theorem by any vector and space. (7%)

3. Fig. 1 shows the section through a long cylindrical capacitor of internal radii  $r_1$  and  $r_2$ . There are two kinds of the dielectric materials in the capacitor. Find the capacitance per unit length. The distribution of the dielectric constants is: (20%)

Fig. 1

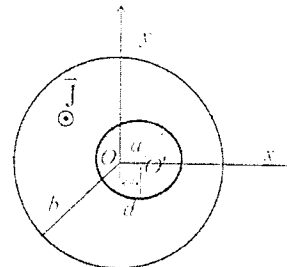


$$\epsilon = \begin{cases} \epsilon_1, & r_1 < r < a \\ \epsilon_2, & a < r < r_2 \end{cases}$$

4. The x-y plane is the interface between the free space ( $z > 0$ ) and the dielectric material  $\epsilon_1$  ( $z < 0$ ). An electric field  $\vec{E}(z > 0) = E_x \hat{x} - E_z \hat{z}$  exists in the free space region. Find the electric field  $\vec{E}(z < 0)$  in the dielectric material in terms of  $E_x$  and  $E_z$ . (15%)

5. There is an off-center cylindrical cavity that is cut in an infinitely long straight cylindrical conductor carrying a uniform current density. The axis of the cylindrical cavity is displaced from that of the conducting part by a distance  $d$ . Refer to the cross section in Fig. 2. The uniform axial current density is  $\vec{J} = J\hat{z}$ .

Fig. 2



- (a) Find the magnitude and direction of the magnetic flux density  $\vec{B}$  in the cylindrical cavity. (10%)
- (b) Prove that  $\vec{B}$  in the cylindrical cavity is constant. (6%)

6. A pair of length  $l$ , width  $b$  the same conductor sheet, placed parallel to each other apart for the  $d$ .  $d \ll b \ll l$ . When using this sheet for the transmission line, the direction of current  $I$  flow along the sheet length, from one stream to go back into by another piece. Assuming uniform distribution of current in the sheet width, omitted edge effects, find the magnetic flux between them and their self-inductance. (16%)

7. A y-polarized uniform plane wave ( $\vec{E}_i, \vec{H}_i$ ) with a frequency 150 MHz propagates in air in the +x-direction and impinges normally on a perfectly conducting plane at  $x=0$ . Assuming the amplitude of  $\vec{E}_i$  to be 12 mV/m, write the instantaneous expression for (a)  $\vec{E}_i$  and  $\vec{H}_i$  of the incident wave (6%); (b)  $\vec{E}_r$  and  $\vec{H}_r$  of the reflected wave (4%); and (c)  $\vec{E}_t$  and  $\vec{H}_t$  of the total wave in air. (4%) (d) Determine the location nearest to the conducting plane where  $\vec{E}_t$  is zero. (4%)