

國立台灣科技大學一百學年度碩士班招生試題

系所組別：電機工程系碩士班己二組

科目：電磁學

Problem 1 (total 10 points)

In Fig. 1, consider a TM wave propagating in the material media toward the $+z$ direction. In Region 1 ($z < 0$), the displacement vector ($\mathbf{D}_1$) is $\mathbf{D}_1 = \epsilon_0 E_0 (\mathbf{a}_x + 3\mathbf{a}_z) \cos(\omega t - \beta z)$ and the permittivity (ϵ_1) is $2\epsilon_0$. In Region 2 ($z > 0$), the permittivity (ϵ_2) is unknown but the displacement vector ($\mathbf{D}_2$) is $\mathbf{D}_2 = \epsilon_0 E_0 (2\mathbf{a}_x + \mathbf{a}_z) \cos(\omega t - \beta z)$. An additional surface free charge density ρ_s (C/m^2) exists at the interface of the two dielectric media.

Please answer the following questions:

- Determine the relative dielectric constant in Region 2. (5%)
- Determine the surface free charge density ρ_s at the interface. (5%)

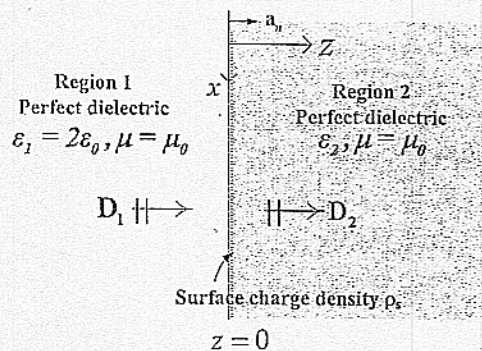


Fig. 1

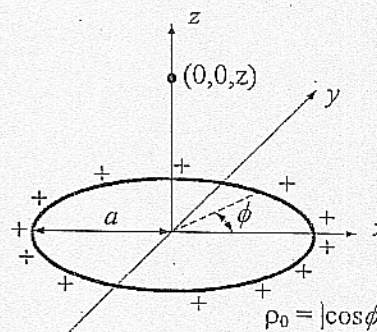


Fig. 2

Problem 2 (total 10 points)

Consider a circular ring of radius a lying in the xy -plane in Fig. 2. Assume a nonuniformly-distributed line charge with density $\rho_0 = |\cos \phi|$ along the ring, find the electric field intensity at a point $(0,0,z)$ on the z -axis.

Problem 3 (total 15 points)

Consider two infinite plane parallel current sheets in free space, spaced $\lambda/4$ apart and carrying currents as given by

$$\begin{aligned} \mathbf{J}_{s1} &= -K J_{s0} \mathbf{a}_x \sin \omega t - \mathbf{a}_y J_{s0} \cos \omega t & \text{for } z = 0 \\ \mathbf{J}_{s2} &= -\mathbf{a}_x J_{s0} \cos \omega t & \text{for } z = \lambda/4 \end{aligned}$$

K is an unknown constant. Please answer the following questions:

- Determine the value of K such that the total field in the $z > \lambda/4$ region is a RHCP wave. (5%)
- Determine the value of K such that the total field in the $z > \lambda/4$ region is a LHCP wave. (5%)
- Determine the value of K such that the total field in the $z > \lambda/4$ region is a linear-polarized wave along the y direction. (5%)



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(總分為100分)

Problem 4 (total 15 points)

The electromagnetic field of a uniform plane wave in a lossy medium is given by

$$\mathbf{E} = e^{-10\pi z} \cos(2 \times 10^6 \pi t - 10\pi z + 45^\circ) \mathbf{a}_x \text{ (V/m)}$$

$$\mathbf{H} = 5e^{-10\pi z} \cos(2 \times 10^6 \pi t - 10\pi z) \mathbf{a}_y \text{ (A/m)}$$

Please answer the following questions:

- Determine the conductivity of the medium. (The permeability of the medium is μ_0) (5%)
- Determine the intrinsic impedance of the medium. (5%)
- Determine the skin depth of the medium. (5%)

Problem 5 (total 14 points)

An air-filled coaxial cylindrical conductor has dimensions $a = 2$ mm, and $b = 6$ mm.

$$(\epsilon_0 = 8.854 \times 10^{-12}, \mu_0 = 4\pi \times 10^{-7})$$

- What is its unit length capacitance? (3%)
- What is its unit length inductance? (3%)
- What is its characteristic impedance? (4%)
- What is its characteristic impedance if the cable is filled with Teflon ($\epsilon_r = 2.25$)? (4%)

Problem 6 (total 15 points)

Using the give B - H curve in Fig. 3, find

- Find the unit length reluctance of a toroidal magnetic circuit made of annealed sheet steel with $A = 3$ cm², when the applied magnetic field intensity is $H = 500$ A/m. (5%)
- For the toroidal magnetic circuit described above, if the current magnitude is 2 mA and $l = 10$ cm, what is the coil turn number required to produce $H = 500$ A/m. (5%)
- For above toroidal magnetic circuit, if the coil turn number is doubled, what is the resulting reluctance? (5%)

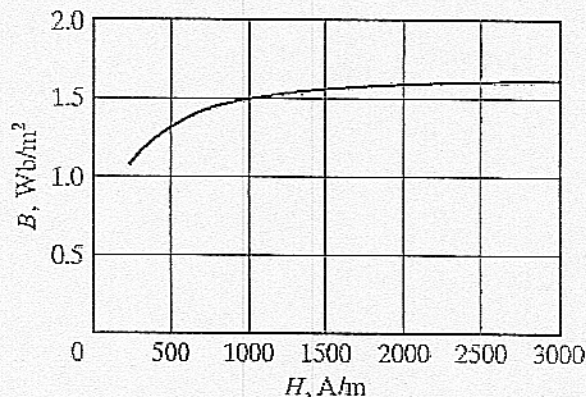


Fig. 3



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Problem 7 (total 21 points)

For points on Smith Chart shown below (Fig. 4), assuming the characteristic impedance of the line is 75Ω , find

- the reflection coefficient at Point A in polar form. (4%)
- the impedance at Point B. (4%)
- the standing wave ratio at Point A. (4%)
- the minimum transmission line length (in wavelength) required to move Point C to Point D when moving toward generator. (4%)
- the impedance becomes after connecting an open-ended stub of 0.25λ in parallel at the transmission line's end, which is terminated as Point E. (5%)

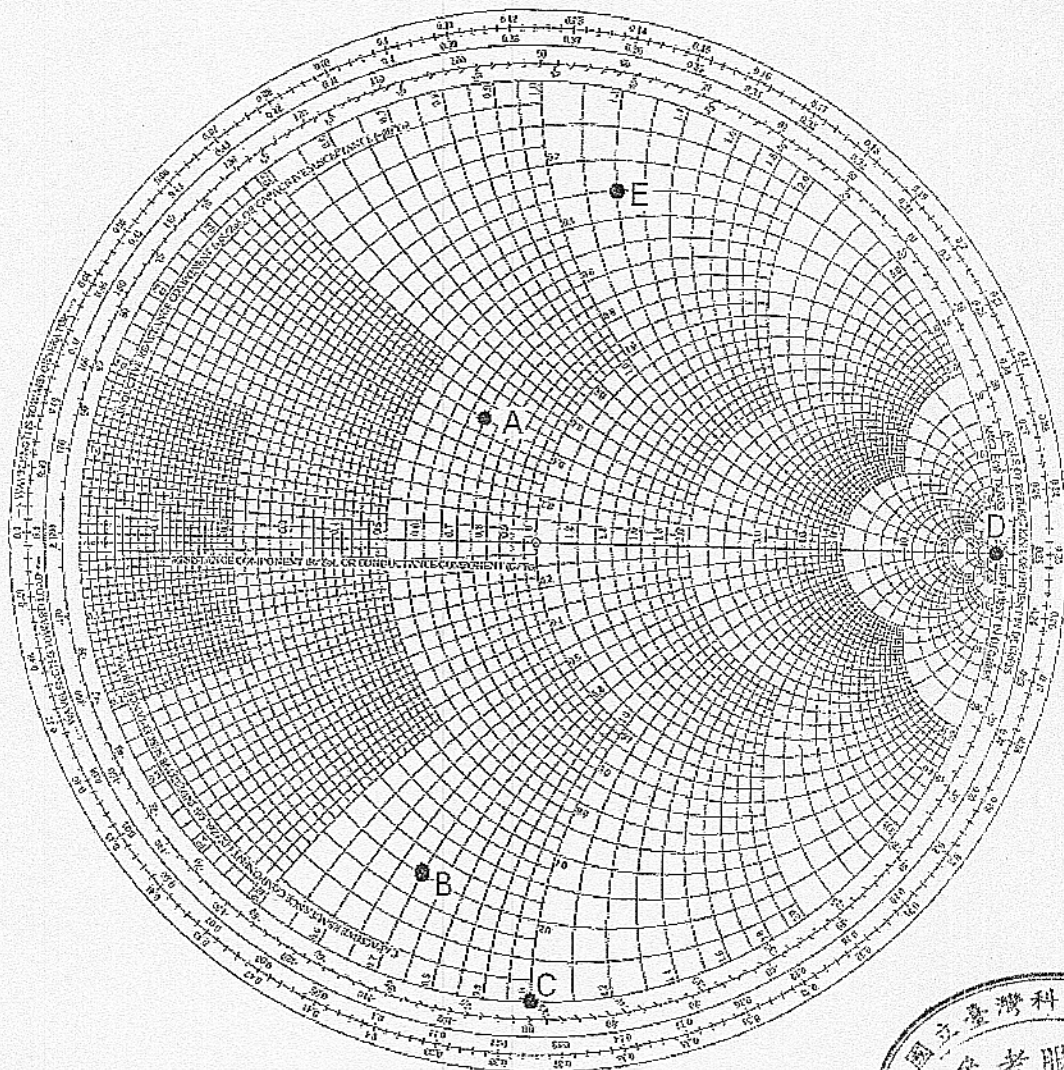


Fig. 4

