

國立臺灣科技大學102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

(總分為100分)

Problem 1 (total 8 points)

An infinitely long, uniformly wound solenoid (S1) of radius 5 mm and having 100 turns per unit length is coaxial with another infinitely long, uniformly wound solenoid (S2) of radius 10 mm and having 200 turns per unit length. Assume S2 core is air and the permeability of the ferrite core of S1 is $\mu = 2000\mu_0$, find the mutual inductance per unit length of the solenoids.

[Hint: The magnetic flux density produced by a solenoid of a unit length is μNI , where N is number of turns per unit length and I is the current in the winding.]

Problem 2 (total 16 points)

In the system shown in Fig. 1, the $\lambda/4$ section of $Z_{02} = 70.7 \Omega$ is used to minimize the SWR to the left of the section. Find

- minimum value of d that minimizes the SWR; (8%)
- corresponding Z_{in} . (4%)
- corresponding SWR. (4%)

[Hint: This problem can be solved using either Smith chart or the analytical approach. If the Smith chart method is used, please state briefly the procedures taken on the Smith chart. 如使用 Smith Chart 求解，請簡要描述在 Smith Chart 上的實行步驟。]

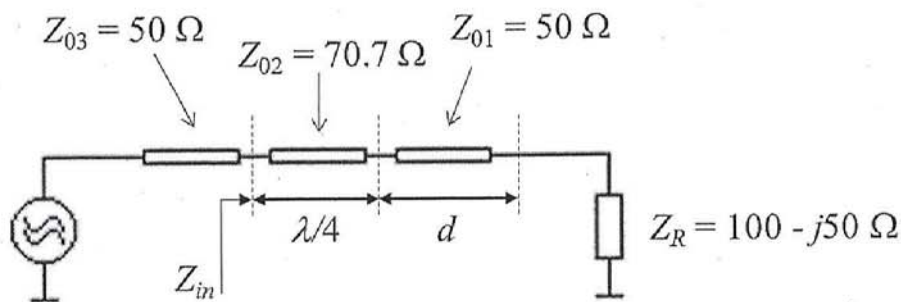


Fig. 1

Problem 3 (total 12 points)

A 100Ω transmission line of 50λ long is terminated by a load impedance $Z_R = 25 \Omega$. If a time average power of 1 W is provided from the generator, determine how much time-average power is delivered to load for

- a lossless line; (6%)
- a lossy line of $\alpha = 0.005 \text{ NP}/\lambda$. (6%)



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Problem 4 (total 14 points)

For a lossless transmission line system shown in Fig. 2, if a wave carrying 1 Watt of power is incident into Line 1, find

- the power reflected from Line 1; (3%)
- the power transmitted to Line 2; (2%)
- the power transmitted to Line 3. (2%)

If a wave carrying 1 Watt of power is incident into Line 2, find

- the power reflected from Line 2; (3%)
- the power transmitted to Line 1; (2%)
- the power transmitted to Line 3. (2%)

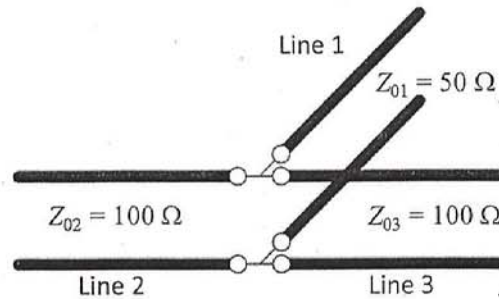


Fig. 2

Problem 5 (total 20 points)

Shown in Fig. 3, in a perfect dielectric medium ($\epsilon_r = 4$, $\mu_r = 1$, $z > 0$), there is an infinite plane current of $\mathbf{J}_s = -\hat{y} \cos 2\omega t$ (A/m) at $z = \lambda/8$. Suppose the $z < 0$ region is filled with a good conductor with conductivity $\sigma = 1 \times 10^7$ S/m ($\mu_r = 1$), answer the following questions:

- Find the phase velocity and intrinsic impedance in the perfect dielectric medium. (5%)
- Find the skin depth in the good conductor if the operating frequency is 1 GHz. (5%)
- Express the instantaneous incident electric field in the $0 < z < \lambda/8$ region. (5%)
- Find the surface current at the interface ($z = 0$) if the conductivity becomes infinite ($\sigma = \infty$). (5%)

[NOTE: $\mu_0 = 4\pi \times 10^{-7}$ H/m]

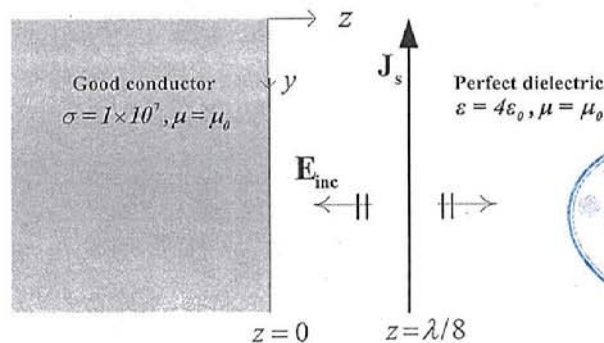


Fig. 3



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Problem 6 (total 20 points)

Consider a plane wave in free space with the electric field given by

$$\vec{E} = E_0 \cos(\omega t - \beta y) \hat{x} - E_0 \sin(\omega t - \beta y) \hat{z}$$

Answer the following questions:

- 1) Determine the polarization sense of this wave. (5%)
- 2) Express the electric field in phasor form. (5%)
- 3) Determine the time-average Poynting vector. (10%)

Problem 7 (total 10 points)

Consider an electric field given by

$$\vec{E} = \hat{x} E_0 y \cos \omega t$$

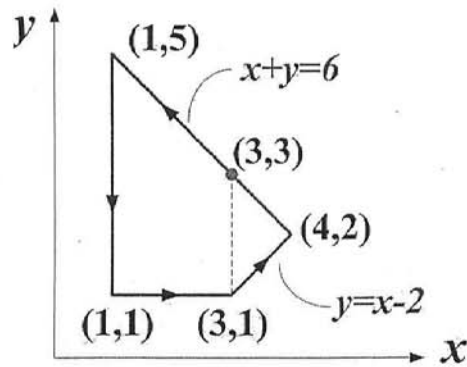
Evaluate the line integral $\oint_C \vec{E} \cdot d\vec{l}$ around the closed loop in Fig. 4.

Fig. 4



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The Complete Smith Chart

Black Magic Design

