台灣聯合大學系統102學年度碩士班考試命題紙

科目：電磁學B(3009)

校系所組：交通大學電子研究所(甲組、乙A組、乙B組)
交通大學生醫工程研究所(乙組)
清華大學光電工程研究所
陽明大學生物醫學工程學系（醫學電子組）

一、(10%) Please derive, and then prove, that the intrinsic impedance η of a good conductor has a phase angle of 45°. Does this mean E is leading H by 45°, or H is leading E by 45°?

二、(20%) As shown Figure 1, please write down the mathematical expression (in phasor) for the incident wave $\mathbf{E}_i$, which is left-hand circularly polarized and is propagating along -x direction. What will be the mathematical expressions for the corresponding reflected wave $\mathbf{E}_r$, and $\mathbf{H}_i$ and $\mathbf{H}_r$? Will the reflected wave be left-hand or right-hand circularly polarized, and why?

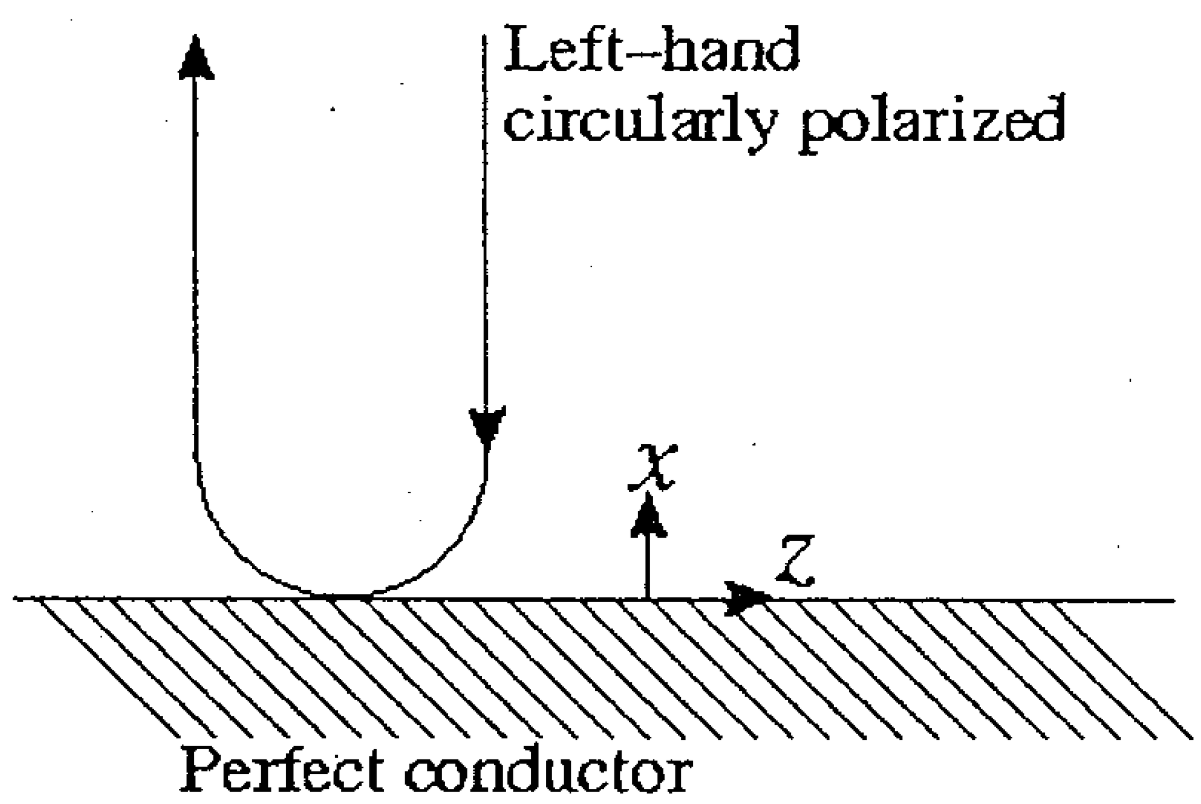

Figure 1

三、(20%) As shown in Figure 2, for an air-filled rectangular waveguide with $a = b = 1$ mm, please write down the mathematical expressions (in phasor) for the $\mathbf{E}$ fields (traveling in +z direction) in TE_{10} and TE_{01} modes. What will be their corresponding cutoff frequency in GHz?.

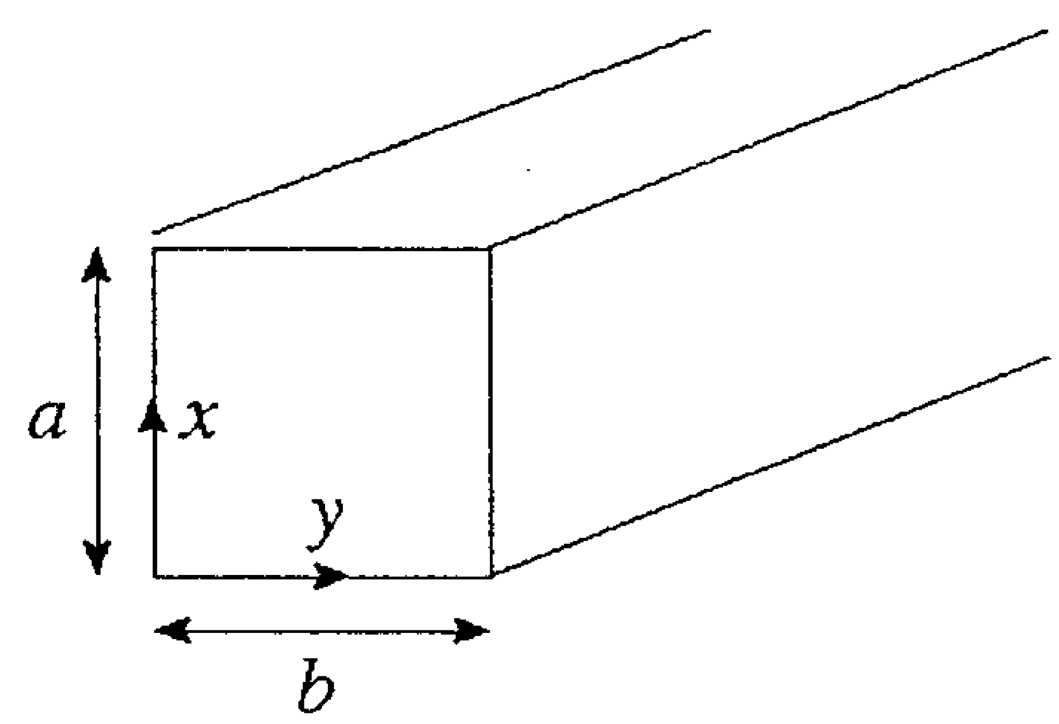

Figure 2

注意：背面有試題

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四、Consider a damped linear oscillator (e.g. an electron bounded to an ion) driven by an input electromagnetic wave:

(一) (9%) What is the phase difference between the oscillator and input electromagnetic wave at (a) $\omega << \omega_0$ (b) $\omega \approx \omega_0$ (c) $\omega >> \omega_0$? ω is the wave frequency and ω_0 is the oscillator resonance frequency. You may analyze the problem by writing down the equation of motion of a driven damped linear oscillator.

(二) (9%) The oscillator mentioned above will emit an output electromagnetic wave, much like an antenna driven by a current source. What is the phase difference between the oscillator and output electromagnetic wave at (a) $\omega << \omega_0$ (b) $\omega \approx \omega_0$ (c) $\omega >> \omega_0$? You may analyze the problem by simply checking Maxwell's equations.

(三) (2%) What will be the phase difference between the input electromagnetic wave and output electromagnetic wave at $\omega \approx \omega_0$?

五、(10%) A lossless transmission line with a characteristic impedance Z_0 is terminated by a load Z_L as shown in Figure 3. Assume the input voltage amplitude is V_i and the phase constant is β. Z_0 and Z_L are real.

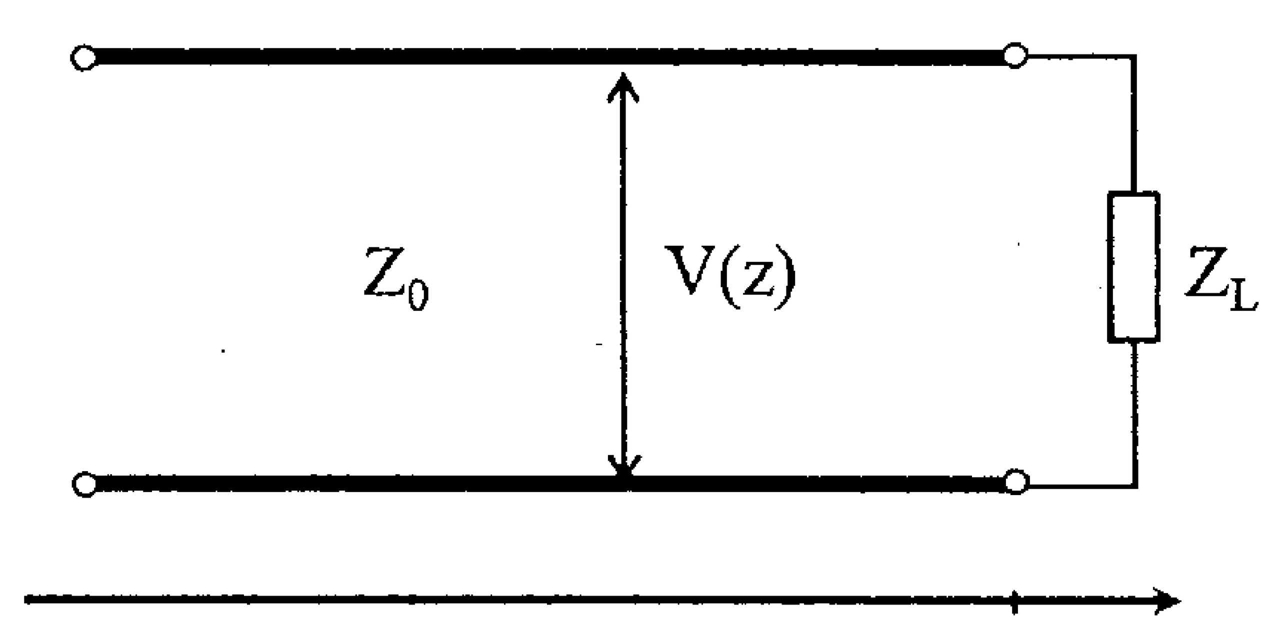

Figure 3

(一) (6%) Express the total voltages V(z) along the transmission line by the superposition of an incident wave and a reflected wave and prove that it can also be expressed as a sum of traveling and standing waves. (Express your answers only in terms of Z_0, Z_L, V_i, β, z.)

(二) (4%) Derive the locations of voltage maxima on the line.

背面有試題

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六、(20%) Consider a possible solution to Maxwell's equations given by

$$\vec{A}(r,t)=\vec{A}_0 e^{i(\vec{k}\cdot\vec{r}-\omega t)},\quad \phi(r,t)=0,$$

where $\vec{A}(r,t)$ is the vector potential and $\phi(r,t)$ is the scalar potential, with which we can have the related electromagnetic fields:

$$\vec{B}=\nabla\times\vec{A}(r,t),\quad \vec{E}=-\nabla\phi-\frac{\partial}{\partial t}\vec{A}(r,t)$$

Further suppose A_0, k, and ω are constants in space-time. Derive and Interpret the constraints on A_0, k, and ω imposed by each of the Maxwell's equations listed below:

(a) $\nabla\cdot\vec{B}=0$,

(b) $\nabla\cdot\vec{E}=0$,

(c) $\nabla\times\vec{E}=-\frac{\partial}{\partial t}\vec{B}$,

(d) $\nabla\times\vec{B}=\frac{1}{c^2}\frac{\partial}{\partial t}\vec{E}$, where c is the speed of light in vacuum.