科目：電磁學 B(3008)

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）

參考用

一、(15%) In free space, a sinusoidal uniform plane wave with the electric field intensity (phasor)

$$\bar{E}_i(y,z) = 2(\bar{a}_y + \bar{a}_z\sqrt{3})e^{j12(\sqrt{3}y-z)} \quad (\text{V/m})$$

strikes the surface of the perfect conductor at $z=0$ as shown in Figure 1,

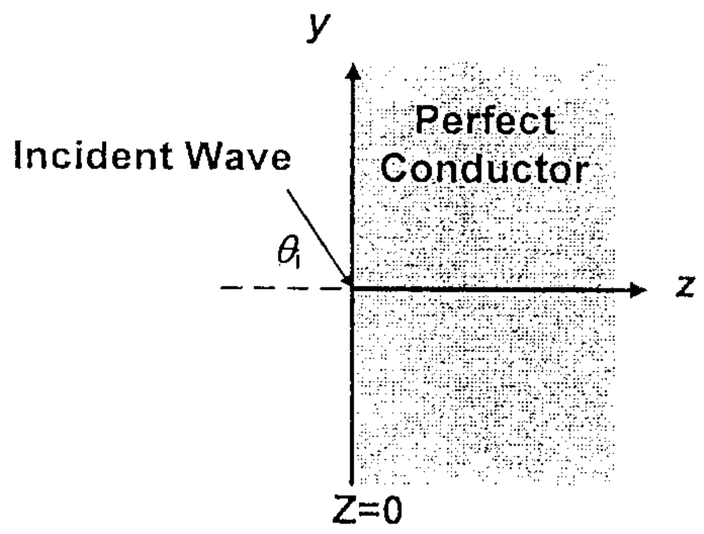

Figure 1.

(1A) (3 points) Find the angular frequency of the wave.

(1B) (2 points) Determine the angle of incidence θ_i.

(1C) (10 points) Show that no average power is propagated in the z direction.

二、(15%) The plane wave propagating in the air has the electric field intensity as follows:

$$\bar{E}(t,x,z) = -\bar{a}_x 1.8\cos(2\pi ft - 4x - 3z) + \bar{a}_y 3\sin(2\pi ft - 4x - 3z) + \bar{a}_z 2.4\cos(2\pi ft - 4x - 3z) \quad (\text{V/m})$$

(2A) (3 points) Find the frequency of the wave.

(2B) (2 points) Find the angle between the z-axis and the propagating direction.

(2C) (6 points) What polarization is this wave (linearly or circularly polarized)? Does the polarization rotate in right hand or left hand?

(2D) (4 points) If this wave is incident on a plane boundary at $z=0$ between the air and a medium of $\varepsilon_r = 16$, what are the transmission (refraction) angle and transmission coefficients for different polarization components of the wave?

注意：背面有試題

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三、 (20%) The parallel plate waveguide shown in Figure 2 is infinite in the y and z directions and subject to the impedance boundary conditions as follows: $\hat{x}\times\vec{E}=\mp\eta\hat{x}\times(\hat{x}\times\vec{H})$, at walls $x=\pm w/2$ with $\mathrm{Re}(\eta)\geq 0$.

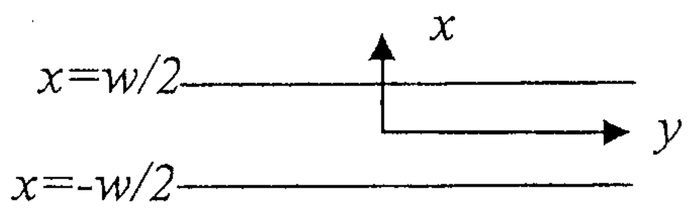

Figure 2

(3A) (12 points) Assuming $\vec{E}=\hat{z}E_z$, determine the transverse resonance condition for modes propagating in the $+y$ direction.

(3B) (8 points) From this condition (or otherwise), are there any η for which lossless propagation can occur?

四、 (10%) Consider a transmission line as shown in Figure 3, where $Z_0=50\ (\Omega)$, $Z_S=50\ (\Omega)$, $Z_L=50-j100\ (\Omega)$, $l=3.2$ (m), $V_0=100$ (V), $\omega=2\pi f$, $f=125$ (MHz), the phase velocity of the voltage/current waves is $v_p=2\times10^8$ (m/s).

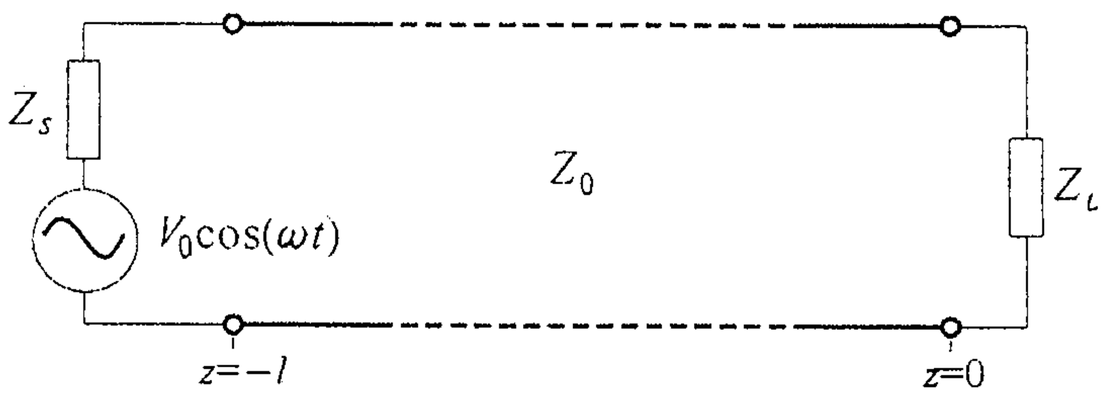

Figure 3

(4A) (5 points) The line impedance is formulated as:

$$Z(z)=Z_0\frac{Z_L-jZ_0\tan(\beta z)}{Z_0-jZ_L\tan(\beta z)},$$

where β is the propagation constant. What is the equivalent impedance Z_{in} of the "loaded transmission line" seen by an observer at the source end ($z=-l$) looking toward to the right hand side?

(4B) (5 points) What are the powers supplied by the source P_{tot}, and delivered to the load P_L, respectively?

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參考用

五、 (10%) Consider plane waves:

(5A) (4 points) Write down the mathematical expression for a plane wave. Explain the meaning of each parameter.

(5B) (6 points) Describe and plot the major difference between a spherical and a plane wave. Is there any chance a spherical wave can be regarded as a plane wave? Use simple mathematical expressions to support your answer.

六、 (10%) Consider radiation: Explain why an accelerating charge may leads to radiation of light? You need to support your explanation using precise mathematical equations, as well as simple plots.

七、 (20%) For Figure 4, assuming an object (in vacuum) with a refractive index $n=1.5$ is incident by light with an angle of $\theta_i = 60^\circ$.

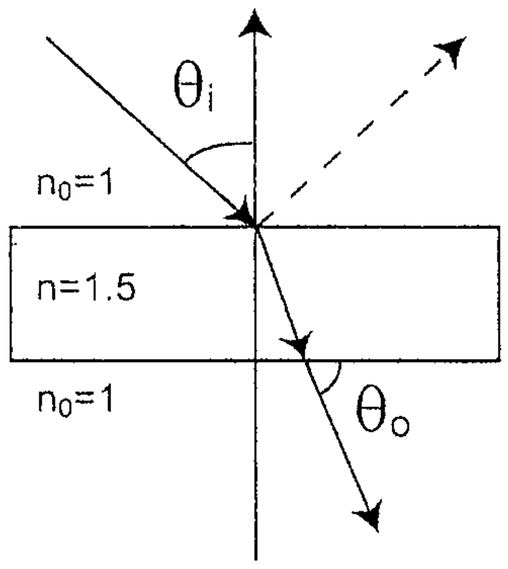

Figure 4

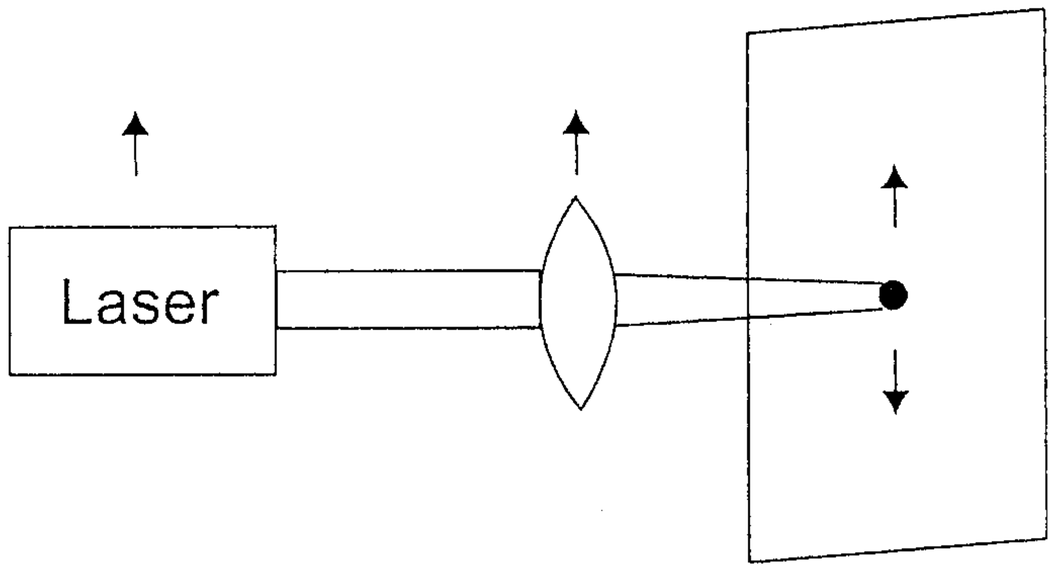

Figure 5

(7A) What is the angle θ_o after the light passing through the object?

(7B) Will you see any reflected light (dashed line)?

(7C) How large should θ_i be to have total internal reflection in the slab?

For Figure 5, a collimated laser light is focused on the screen by a very thin lens.

(7D) Will the light spot on the screen move up or down if the lens is moved upward?

(7E) Will the light spot on the screen move up or down if the laser is instead moved upward?