科目：電磁學 B(5008)

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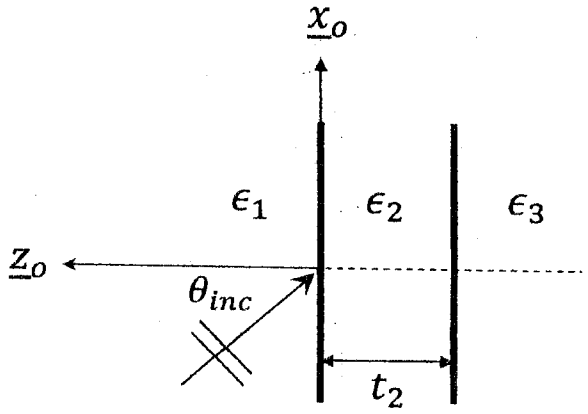
Problem 1. (10/100 points)
Derive the outward-traveling planes waves due to a current sheet $\underline{J} = \underline{x}_o J_o$ placed over the $z = 0$ plane.

Problem 2. (20/100 points) 2.1:5points, 2.2:7points, 2.3:8points
Consider a three-medium configuration shown in attached figure. The relative dielectric constants of the media are $\epsilon_1 = 11.8, \epsilon_1 = 1.0$, and $\epsilon_3 = 11.8$, respectively. The incident angle, which is counted from the z-axis with the coordinate system attached to the figure, of the plane wave is designated as θ_{inc}. The thickness of the medium #2 is denoted as t_2. Here, we assumed that there are no fields and structure variation along the y-axis. Answer the following questions. (1) Using the attached coordinate system to define TE (transverse electric to z) or perpendicularly polarized wave, TM (transverse magnetic to z) or parallel-polarized wave, and TEM wave. (2) Does the total transmission phenomenon occur for both TE- and TM- incident waves? Please also write down the equation for predicting the incident angle causing the occurrence of total transmission. (3) If the wave is incident at an incident angle greater than the critical angle from a denser medium to a less dense medium, can we receive the real power in medium #3? Please explain why or why not.



Problem 3. (15/100 points)
If we add the normalized shunt admittance $1+j1$ at a quarter wavelength away from an open-circuit load, what is the percentage of incident power being absorbed by this lossy $1+j1$ normalized shunt admittance?

Problem 4. (7/100 points) 4(a):3points, 4(b):4points
Answer the following questions. (a) Define and identify the dominant mode of propagation in a rectangular metallic waveguide whose width a along x exceeds its height b along y. (b) An empty (air-filled) rectangular waveguide of cross-sectional dimensions $a : b = 2 : 1$ operates in the dominant mode at a nominal frequency of 1.5 times the cutoff frequency. Determine the dimensions of the waveguide for operation at 7.5 GHz.

Problem 5. (8/100 points) 5(a):4points, 5(b):4points
A vehicular tunnel of width a = 12m and height b = 6m can be modeled as a perfectly conducting rectangular waveguide. The propagation constant in the waveguide is given by:

$$\gamma = \sqrt{(m\pi/a)^2 + (n\pi/b)^2 - \omega^2\mu\varepsilon}$$

where μ and ε are the free-space permeability and permittivity and ω is the angular frequency.
(a) An automobiie equipped with an AM/FM radio receiver is traveling in the tunnel. Can it receive FM (100 MHz) broadcast? (b) Can it receive AM (1 MHz) broadcast? If not, what can be installed in the tunnel to enable AM broadcast to be received?

注意：背面有試題

Problem 6. (7/100 points)
Consider the following mathematical expressions, where x and t are expressed in meters and seconds, respectively. Ψ is the displacement.

(1) $\Psi(x,t)=\dfrac{25}{4+(3-x-\frac{1}{2}t)^2}$ (2) $\Psi(x,t)=2e^{-(3t-5-2(x-1))^2}$

(a) (3 %) Which of the above expressions correspond to traveling waves? Please answer: (1), (2), or both. Explain your reason.
(b) (4 %) From (a), for each of the qualified expressions, please give speed and direction of motion.

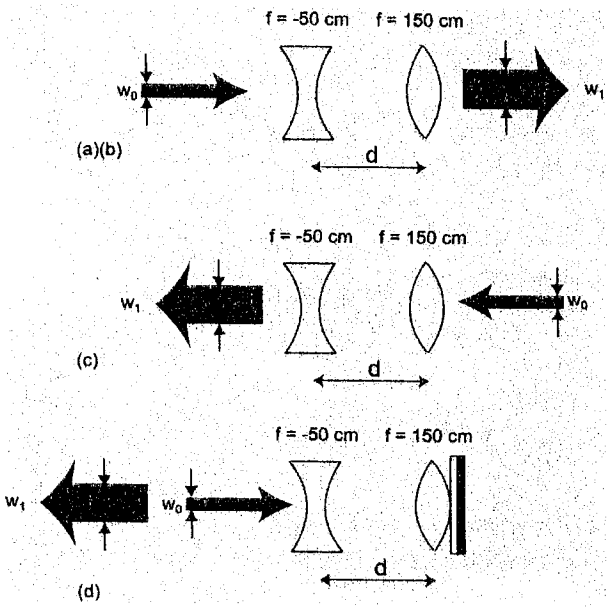
Problem 7. (13/100 points)
An electromagnetic wave in vacuum is described in complex representation as below.

$\vec{E}=(j\hat{a}_x-\hat{a}_y)e^{-jz}$ (V/m)

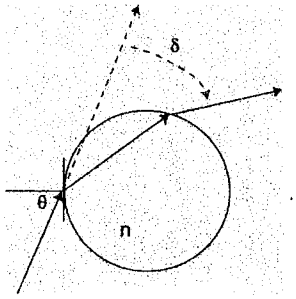
For this problem, only natural constants ε_0 and μ_0 are accepted in your answer and you may leave it in symbolic form. Other symbols are not accepted. (ε_0 and μ_0 are the permittivity and permeability in vacuum, respectively.)
(a) (1 %) What is the polarization of the electromagnetic wave (linear, circular, elliptical)?
(b) (2 %) Please determine its frequency.
(c) (3 %) Give the corresponding real time-domain representations for $\vec{E}$.
(d) (4 %) Please determine the corresponding magnetic field vector $\vec{H}$ in complex representation.
(e) (3 %) Please determine the time-average Poynting vector (including magnitude and direction).

Problem 8. (10/100 points)
Assuming an object (in vacuum) with a refractive index $n=\sqrt{3/2}$ is incident by light with an angle of $\theta=60^\circ$. What is the deviation angle δ after the light passing through the object?

Problem 9. (10/100 points)
Consider a thin-lens combination as shown below (not to scale). For a parallel incident light with a diameter of w_0 = 1 cm, (a) How far should the two lenses be arranged so that the output light can still be collimated? (d = ?) (3 %) With the d obtained in part (a), (b) What would be the diameter at the output? (w_1 = ?) (2 %) (c) What would be the diameter at the output if the light is coming from the right? (w_1 = ?) (2 %) (d) What would be the diameter at the output if the light is reflected back by a mirror? (w_1 = ?) (3 %)



Problem 9



Problem 8