

※請在答案卷內作答

1. (10%) A laser beam in some liquid has its electric field described as the following:

$$\vec{E}(t, z) = \hat{a}_x 3 \cos(6\pi \times 10^{14} t - 4\pi \times 10^6 z) - \hat{a}_y 3 \sin(6\pi \times 10^{14} t - 4\pi \times 10^6 z) \text{ (V/m)}$$

Answer the following questions:

- What is the polarization status? (2%)
  - What is the propagation direction? (2%)
  - What is its wavelength and frequency in the liquid? (2%)
  - What is the phase velocity in this liquid? (2%)
  - Is this laser beam a UV, visible, near-infrared, mid-infrared, or far-infrared light (2%)?
2. (10%) Given that  $\vec{H} = \hat{a}_y 2 \sin(6\pi \times 10^9 t - \beta z)$  (A/m) in air (source free), find (a)

$$\vec{E} \text{ (5%) and (b) the power density (5%). } (\epsilon_0 \sim \frac{1}{36\pi} \times 10^{-9} \text{ F/m})$$

3. (10%) What is the fundamental mode of a planar metallic waveguide?
4. (10%) Calculate the capacitance of two concentric spherical shells of radii  $a$  and radii  $b$ . The inner shell is at the potential of  $V_0$ , the outer shell is grounded, and the dielectric constant of the material between the two shells is  $\epsilon$ .
5. (10%) The normalized radiation intensity of a certain antenna is given by

$$F(\theta) = \begin{cases} \cos^2 \theta, & \text{for } 0 \leq \theta \leq \frac{\pi}{2} \\ 0, & \text{for } \frac{\pi}{2} \leq \theta \leq \pi \end{cases}$$

, where  $\theta$  is in radian. Determine the half-power beamwidth  $\beta$ .

6. (10%) When sunlight reflected from the surface of water is viewed through a linearly polarizing glass, the apparent glare from the water is reduced.
- (a) Suppose you have a beachfront house, and you want to use polarizing glass to reduce the glare from the sunlight reflected from the ocean. How should you

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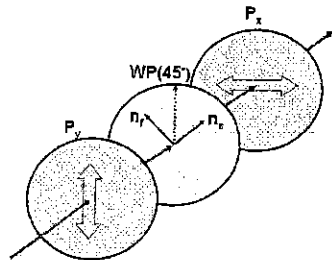
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orient the polarizing glass to obtain the optimized reduction of the glare? (5%)  
(Please describe it in terms of the orientation of the transmission axis)

(b) From which angle of reflected sunlight will you polarizing glass be most effective? (5%) (Assume that the index of refraction of water is 1.33.)

7. (10%) Consider an input plane wave with optical intensity  $I_0$ , and left-handed circularly polarized, passing through the following set of 3 optical elements (i.e., a half wave-plate rotated by  $45^\circ$  sandwiched between a pair of cross-polarizers). Calculate the optical intensity of the output wave.



8. (10%) A plan wave traveling in a medium 1 with  $\epsilon_{r1} = 4.00$  is incident to a medium 2 with  $\epsilon_{r2} = 2.25$ . Both media are non-magnetic and non-conductive. Now the electric field of the normal incident EM field is described as

$$\vec{E}_i = \hat{y} 8 \cos(4\pi \times 10^{14} t - \beta z) \text{ (V/m)}.$$

- (a) What is the electric field of the reflected wave? (5%)  
(b) What is the value of  $\beta$ ? (5%)

9. (10%) A  $50\Omega$  lossless transmission line is to be matched to a resistive load impedance with  $Z_L = 300\Omega$  via a quarter-wave section, thereby eliminating the reflections along the feedline. Find the required characteristic impedance of the quarter-wave transformer.

10. (10%) Given that the skin depth for graphite(石墨) at 100 MHz is 0.16 mm, determine the distance that a 100 MHz wave travels in graphite such that its field intensity (power) is reduced by 30 dB.

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