

# Quiz 4: Fields & Waves (ECE230), Winter 2023

Duration: 1 hr, Total: 20 points (Attempt all questions)

\*\*\*\* Imp: Tick the correct alternatives in the question paper itself for MCQs.

\*\*NO credit will be given to the answers that do not accompany proper explanation.

\*\*Any case of copying/cheating will be dealt as per institute guidelines.

\*\*For MCQs, choose correct option(s). If multiple options are correct, you need to choose all of them for full point.

\*\* Unless stated otherwise, all questions carry 1 mark.

\*\*For ALL questions (including MCQs) that involve numerical calculations you need to show the calculations in rough page provided.

1. Electrodynamical field in free space is: (i) irrotational, (ii) divergence-less, (iii) solenoidal, (iv) none of the above. [1 point]

2. Consider an electromagnetic wave impinging on a very thin metal plate. Which of the following statements are true: (a) the electric field inside the metal is non-zero if the conductivity is finite. (b) the electric field in the metal is non-zero if the conductivity is finite and the plate is very thin. (c) the field on the other side of the plate is zero if conductivity is finite. (d) the field on the other side of the plate is zero if conductivity is infinite and the plate is thick. [1 point]

3. A certain wave is represented by:  $\exp i(20x + 10t)$ . The velocity and wavelength are: 0.2 m/s [2 points]

4. The voltage in a transmission line is given by:  $V = [6\exp(ikz) + 3\exp(-ikz)]$ . The voltage SWR is: 3 [2 points]

The current SWR is: 3/2 [2 points]

5. Suppose, you are shining red light from a glass slab (refractive index = 1.5) to air. (a) The reflection coefficient is: -0.2 [4 points]

(b) The reflected electric field flips sign (Yes/No): Yes

(c) The transmission coefficient is: 0.8

(d) The SWR is: 1.5

6. The electric field of an uniform plane EM wave propagating in a certain medium in the xy-plane is represented as:  $E(x, y, t) = \hat{x}\exp[i(2000t - 3x - 4y)]$  [1+1+1+1+2=6 points]

The polarization is: S

The wavelength is: 1.25 m

The speed is: 400 m/s

The unit vector along the direction of propagation is:  $\hat{z}$

The direction of magnetic field is:  $+\hat{z} - \hat{y}$

7. A transmission line has the following per unit length parameters:  $4\mu H/m$  and  $10nF/m$ . [4 points]

The characteristic impedance of the line is: 20 ohm

The propagation velocity of the voltage wave is:  $5 \times 10^6 m/s$

In order to have zero reflection, the line must be terminated with a load of: 20 ohm

If the line is terminated with a  $40\Omega$  load, the load reflection coefficient for voltage is: 0.33

$\sigma = \infty$   
P.F.C.  
 $H, E = 0$   
can't penetrate into  $\sigma = \infty$

$$\vec{E} \times \vec{B} = \frac{2B}{36}, \quad \vec{D} \cdot \vec{E} = \epsilon_0$$

$$\text{here } Z_0 = \sqrt{\frac{\mu}{\epsilon}}$$

$$\vec{E} \times (\hat{x} + \hat{y}) = -\hat{y} - \hat{x}$$

1.5 glass slab to air