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EHB 313-E
HW-1

Q1

1) $y_1(x,t) = 4(\cos[20t - 30x])$

$y_2(x,t) = -4(\cos[20t + 30x])$

$|y_s| = |y_1 + y_2|$ is a max, interfere const. , $|y_s|$ is minimum interfere dest.

a) Propagation of waves? ⇒ If time goes up, inside of cosine should stand constant.

So:

$y_1(x,t) \Rightarrow$ is positive x- direction

$y_2(x,t) \Rightarrow$ is negative x-direction.

b) $t = \left(\frac{\pi}{50}\right) \Rightarrow$ $y_1 = 4\cos\left(\frac{2\pi}{5} - 30x\right)$

$y_2 = -4\cos\left(\frac{2\pi}{5} + 30x\right)$ and $y_s = y_1 + y_2$

Reminder!

$\cos(a+b) - \cos(a-b) = 2\sin a \sin b$

$$y_s = 4\left[\underbrace{\cos\left(\frac{2\pi}{5} - 30x\right) - \cos\left(\frac{2\pi}{5} + 30x\right)}\right]$$

$$y_s = 4 \cdot 2 \cdot \sin\frac{2\pi}{5} \cdot \sin 30x = \underbrace{8 \cdot \underbrace{\sin\frac{2\pi}{5}}_{0{,}951}} \cdot \sin 30x$$

$$y_s = 7{,}608 \cdot \boxed{\sin 30x} \; (\max = 1)$$

$y_s = 7{,}608$ max when $\sin 30x = 1$.

$\sin\left(\frac{\pi}{2} + 2\pi n\right) = 1$ $\qquad \frac{\pi}{2} + 2\pi n = 30x$

$n = 0, 1, 2, \ldots$

$$\boxed{x = \frac{\pi}{60} + \frac{2\pi n}{30}} \; n = 0, 1, 2, 3 \ldots$$

c) Same equations as (b) $\boxed{t = \frac{\pi}{50}}$

$y_s = 7{,}608 \cdot \sin 30x$, $|y_s|_{min} = 0$

$\sin(\pi n) = 0$

$30x = \pi n$, $\boxed{\frac{\pi n}{30} = x}$ when $n = 0, 1, 2 \ldots$

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Question 2

Phasor form : $E(x,t) = Re\{\underbrace{E(x)}_{\text{phasor form}} \cdot e^{j\omega t}\}$

a) $\vec{A} = 3 \cdot \sin(2t + \frac{\pi}{3}) \cdot \vec{e_x} + 5 \cdot \cos(2t + \pi/6) \cdot \vec{e_y}$

$\vec{A} = 3 \cdot \sin(2t + \frac{\pi}{2} - \frac{\pi}{6}) \vec{e_x} + 5 \cos(2t + \pi/6) \vec{e_y}$

$\vec{A} = 3 \cos(2t - \frac{\pi}{6}) \vec{e_x} + 5 \cos(2t + \frac{\pi}{6}) \cdot \vec{e_y}$

$$\boxed{\tilde{A} = 3 \cdot e^{-\pi/6 j} \cdot \vec{e_x} + 5 \cdot e^{j\pi/6} \cdot \vec{e_y}}$$

b) $\vec{B} = \left(\frac{1000}{\rho}\right) \cdot \sin(\omega t - 2\pi z) \vec{e_\rho}$

$\vec{B} = \left(\frac{1000}{\rho}\right) \cdot \cos(\omega t - 2\pi z - \frac{\pi}{2}) \cdot \vec{e_\rho}$

$$\boxed{\tilde{B} \Rightarrow \left(\frac{1000}{\rho}\right) \cdot e^{-j\left(\frac{\pi}{2} + 2\pi z\right)} \cdot \vec{e_\rho}}$$

c) $\vec{C} = \left(\frac{\cos\theta}{r}\right) \cdot \sin(\omega t - 4r) \cdot \vec{e_\theta}$

$\vec{C} = \frac{\cos\theta}{r} \cos(\omega t - 4r - \frac{\pi}{2}) \vec{e_\theta}$

$$\boxed{\tilde{C} = \frac{\cos\theta}{r} \cdot e^{-j\left(\frac{\pi}{2} + 4r\right)} \cdot \vec{e_\theta}}$$

D) $\vec{D} = 10 \cos(k_1 x) \cdot \cos(\omega t - k_2 z) \cdot \vec{e_y}$

$\tilde{D} = 10 \cos(k_1 x) \cdot e^{-jk_2 z} \cdot \vec{e_y}$

Question 3

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a) $\tilde{A} = -5 . e^{j\pi/3} \Rightarrow \dot{A} = -5 . \cos(wt + \pi/3)$

b) $\tilde{B} = 6 + 8j \Rightarrow \ddot{B} = 6 . \cos(wt) + 8 . \cos(wt + \pi/2)$

c) $\tilde{C} = -j \Rightarrow C = -\cos(wt + \pi/2)$ or $C = \cos(wt - \pi/2)$

d) $D = 2 . e^{j\pi/6} \Rightarrow D = 2 . \cos(wt + \pi/6)$