

ECE3411 1) Given $V(z, t) = 5 \sin\left(\frac{\pi}{6} + 4\pi z - \pi 10^9 t\right)$ (V)

Basic Relationships 1.

- a) to determine the direction of propagation, set the argument of the sine function constant and determine if for increasing time t , z increases or decreases

$$\frac{\pi}{6} + 4\pi z - \pi 10^9 t = a$$

$$\Rightarrow \frac{dz}{dt} = \frac{\pi \cdot 10^9}{4\pi} t > 0 \Rightarrow \text{wave}$$

is traveling in the positive z -direction

b) $\sin\left(\frac{\pi}{6} + 4\pi z - \pi 10^9 t\right) = \sin\left(\frac{\pi}{6} + \beta z - \omega t\right)$

$$\Rightarrow \omega = \pi \cdot 10^9 \frac{1}{s} = 2\pi f$$

$$f = \frac{1}{2} 10^9 \frac{1}{s} = \boxed{500 \text{ MHz}}$$

c) $\beta = 4\pi = \frac{2\pi}{\lambda}$

$$\Rightarrow \boxed{\lambda = 0.5 \text{ m}}$$

d) $v_p = \frac{\omega}{\beta} = \lambda f$

$$= \frac{\pi \cdot 10^9}{4\pi} \frac{\text{m}}{\text{s}} = \boxed{2.5 \times 10^8 \frac{\text{m}}{\text{s}}} = 0.5 \text{ m} \cdot 5 \times 10^8 \frac{1}{\text{s}} = 2.5 \times 10^8 \frac{\text{m}}{\text{s}}$$