ECSE 2100 – Fields and Waves I
Fall 2006
Homework #1

solution

1. For the following wave expressions, indicate if the wave is standing or traveling. If the wave is traveling, find the direction of propagation and the velocity.

a) $\sin(1000t + 0.2x)$ Traveling in $-x$, $v = \frac{\omega}{\beta} = 5\times10^3$ m/s

b) $\cos(10^8 t - 0.01z)$ Traveling in z, $v = \frac{\omega}{\beta} = 10^8$ m/s

c) $\cos(377t)\sin(5x)$ Standing

2. Find the phasor representation of the following expressions

a) $v(t) = 50\cos\left(\omega t - \frac{2\pi}{3}\right)$ $\tilde{V} = 50e^{-j2\pi/3} = 50e^{-j2\pi/3}$

b) $v(t) = 100\sin\left(\omega t + \frac{\pi}{3}\right) = 100\cos\left(\frac{\pi}{2} - \left(\omega t + \frac{\pi}{3}\right)\right) = 100\cos(\omega t - \pi/6)$ $\tilde{V} = 100e^{-j\pi/6}$

c) $v(t) = 3\sin\left(\omega t + \frac{\pi}{3}\right) + 8\cos\left(\omega t - \frac{2\pi}{3}\right) = 3\cos\left(\frac{\pi}{2} - \left(\omega t + \frac{\pi}{3}\right)\right) + 8\cos\left(\omega t - \frac{2\pi}{3}\right)$

$= 3\cos(\omega t - \pi/6) + 8\cos\left(\omega t - \frac{2\pi}{3}\right)$ $\tilde{V} = 8.54e^{-j1.9}$ $= 8.54e^{-j1.7}$

3. Find the time domain expression for the following phasors.

a) $\tilde{V} = 9 + j3V = 9.487e^{j18.4^\circ}$, $v(t) = 9.487\cos(\omega t + 18.4^\circ)$

b) $\tilde{V} = 2.7e^{j\frac{3\pi}{4}}V$ $v(t) = \mathrm{Re}(2.7e^{j\frac{3\pi}{4}}e^{j\omega t}) = 2.7\cos\left(\omega t + \frac{3\pi}{4}\right)$

4. A wave is described by $v(t,z) = 30.0e^{-\alpha z}\sin(2\pi\times10^6 t - \pi z)V$. Find the frequency, wavelength and velocity. At z = 2m the magnitude is measured as 1V. Find the attenuation constant.

$f = 10^6$ Hz, $\beta = \pi$, $\lambda = \frac{2\pi}{\beta} = 2$, $v = \frac{\omega}{\beta} = \frac{2\pi\times10^6}{\pi} = 2\times10^6$ m/s

$30e^{-2\alpha} = 1$, $\Rightarrow \alpha = -\frac{1}{2}\ln\frac{1}{30} = 1.7$