EEC 130A: Homework 1

Due: 3:30 pm, Jan. 15, 2013

1. (4 points) (FAE P1.1*) A 2-kHz sound wave traveling in the x-direction in air was observed to have a differential pressure $p(x,t) = 10$ N/m^2 at $x = 0$ and $t = 50$ μs. If the reference phase of $p(x,t)$ is 36°, find a complete expression for $p(x,t)$. The velocity of sound in air is 330 m/s.

2.†(4 points) (FAE P1.7) A wave traveling along a string in the $+x$-direction is given by

$$y_1(x,t) = A\cos(\omega t - \beta x), \tag{1}$$

where $x = 0$ is the end of the string, which is tied rigidly to a wall, as shown in Fig.1. When wave $y_1(x,t)$ arrives at the wall, a reflected wave $y_2(x,t)$ is generated. Hence, at any location on the string, the vertical displacement y_s is the sum of the incident and reflected waves:

$$y_s(x,t) = y_1(x,t) + y_2(x,t). \tag{2}$$

(a) Write an expression for $y_2(x,t)$, keeping in mind its direction of travel and the fact that the end of the string can not move.

(b) Generate plots of $y_1(x,t)$, $y_2(x,t)$ and $y_s(x,t)$ versus x over the range $-2\lambda \le x \le 0$ at $\omega t = \pi/4$ and at $\omega t = \pi/2$.

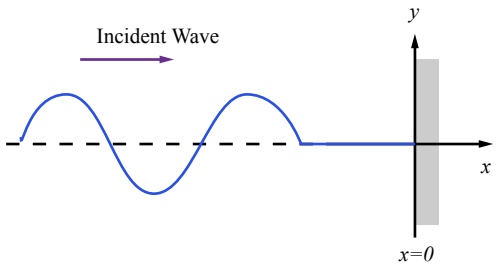

Figure 1: Wave on a string tied to a wall at $x = 0$

3. (4 points) (FAE P1.11) The vertical displacement of a string is given by the harmonic function:

$$y(x,t) = 2\cos(16\pi t - 20\pi x) \qquad (m), \tag{3}$$

*Stands for "Fundamentals of Applied Electromagnetics", 6th Ed., Problem 1.1

†The solution to this problem is available on the CD accompanying the textbook, but I strongly encourage you to try solving the problem on your own or through group discussion.

where x is the horizontal distance along the string in meters. Suppose a tiny particle were attached to the string at $x = 5$ cm. Obtain an expression for the vertical velocity of the particle as a function of time.

4. (4 points) (FAE P1.13) The voltage of an electromagnetic wave traveling on a transmission line is given by

$$\nu(z,t) = 5e^{-\alpha z}\sin(4\pi \times 10^9 t - 20\pi z) \qquad (V), \tag{4}$$

where z is the distance in meters from the generator.

(a) Find the frequency, wavelength, and phase velocity of the wave.

(b) At $z = 2$ m, the amplitude of the wave was measured to be 2 V. Find α.

5. (4 points) (FAE P1.22) If $z = 3 - j5$, find the value of $\ln(z)$.