ECE 341 Homework #1

P1. Problem 1.3 of 8/E of textbook (i.e. Problem **1.1** in 7/E or earlier as shown below):

1.1 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.

P2. Problem 1.2 in Textbook 8/E or earlier versions (Example 1-1 refers to the Example in the text, ***not*** Problem **1.1** in PROBLEMS):

Problem 1.2 For the pressure wave described in Example 1-1, plot

(a) $p(x,t)$ versus x at $t = 0$,

(b) $p(x,t)$ versus t at $x = 0$.

Be sure to use appropriate scales for x and t so that each of your plots covers at least two cycles.

P3. Problem 1.1 in Textbook 8/E (i.e. **Problem 1.3** in earlier versions as shown below):

Problem 1.3 A harmonic wave traveling along a string is generated by an oscillator that completes 180 vibrations per minute. If it is observed that a given crest, or maximum, travels 300 cm in 10 s, what is the wavelength?

P4. Problem 1.5 in Textbook 8/E:

Two waves, $y_1(t)$ and $y_2(t)$, have identical amplitudes and oscillate at the same frequency, but $y_2(t)$ leads $y_1(t)$ by a phase angle of 60°. If

$$y_1(t) = 4\cos(2\pi \times 10^3 t),$$

write down the expression appropriate for $y_2(t)$ and plot both functions over the time span from 0 to 2 ms.

Note: We often call a sinusoidal function of time a "wave." This is not in a strict sense, as a wave is a function of both time and position. Better to say a "waveform" (as you can see with an oscilloscope) or a "signal."

Note: To "lead" means to be ahead of, thus the + sign. It is as if y_2 started earlier: At t = 0, y_1 is at phase zero while y_2 is already at phase 60°.

P5. Problem 1.6 in Textbook 8/E:

The height of an ocean wave is described by the function

$$y(x,t) = 1.5\sin(0.5t - 0.6x) \quad \text{(m)}.$$

Determine the phase velocity and the wavelength and then sketch $y(x,t)$ at $t = 2$ s over the range from $x = 0$ to $x = 2\lambda$.

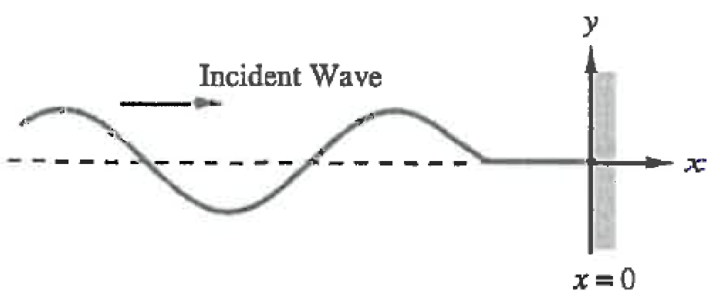
P6. Problem 1.7 in Textbook 8/E:

A wave traveling along a string in the $+x$-direction is given by

$$y_1(x,t) = A\cos(\omega t - \beta x),$$

where $x = 0$ is the end of the string, which is tied rigidly to a wall, as shown in Fig. 1-21 (P1.6). 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 will be the sum of the incident and reflected waves:

$$y_s(x,t) = y_1(x,t) + y_2(x,t).$$



(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 cannot 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 $\omega t = \pi/2$.

P7. Problem 1.8 in Textbook 8/E:

Two waves on a string are given by the following functions:

$$y_1(x,t) = 4\cos(20t - 30x) \quad \text{(cm)},$$
$$y_2(x,t) = -4\cos(20t + 30x) \quad \text{(cm)},$$

where x is in centimeters. The waves are said to interfere constructively when their superposition $|y_s| = |y_1 + y_2|$ is a maximum and they interfere destructively when $|y_s|$ is a minimum.

(a) What are the directions of propagation of waves $y_1(x,t)$ and $y_2(x,t)$?

(b) At $t = (\pi/50)$ s, at what location x do the two waves interfere constructively, and what is the corresponding value of $|y_s|$?

(c) At $t = (\pi/50)$ s, at what location x do the two waves interfere destructively, and what is the corresponding value of $|y_s|$?

P8. Similar to but different from Problem 1.9 in Textbook 8/E:

HW1:P8

(1.9 in 6/E)

Give expressions for $y(x,t)$ for a sinusoidal wave traveling along a string in the negative x-direction, given that $y_{max} = 40$ cm, $\lambda = 30$ cm, $f = 10$ Hz, and

(a) $y(x,0) = 0$ at $x = 0$,

(b) $y(x,0) = 0$ at $x = 7.5$ cm. Notice difference from problem in textbook

P9. Problem 1.14 in Textbook 8/E:

A certain electromagnetic wave traveling in sea water was observed to have an amplitude of 98.02 (V/m) at a depth of 10 m and an amplitude of 81.87 (V/m) at a depth of 100 m. What is the attenuation constant of sea water?

Note: Assume the wave travels downwards.

P10. Problem 1.28 in Textbook 8/E:

Find the phasors of the following time functions:

(a) $v(t) = 3\cos(\omega t - \pi/3)$ (V), Amplitude is 9 in 7/E and 6/E of textbook

(b) $v(t) = 12\sin(\omega t + \pi/4)$ (V),

(c) $i(x,t) = 2e^{-3x}\sin(\omega t + \pi/6)$ (A), Again, amplitude different in newer versions

(d) $i(t) = -2\cos(\omega t + 3\pi/4)$ (A),

(e) $i(t) = 4\sin(\omega t + \pi/3) + 3\cos(\omega t - \pi/6)$ (A).

P11. Problem 1.27 in Textbook 8/E:

Find the instantaneous time sinusoidal functions corresponding to the following phasors:

(a) $\tilde{V} = -5e^{j\pi/3}$ (V),
(b) $\tilde{V} = j6e^{-j\pi/4}$ (V),
(c) $\tilde{I} = (6 + j8)$ (A),
(d) $\tilde{I} = -3 + j2$ (A),
(e) $\tilde{I} = j$ (A),
(f) $\tilde{I} = 2e^{j\pi/6}$ (A).