ECE 341 Homework #1

P1. Problem 1.1 in Textbook:

**Problem 1.1** A 2-kHz sound wave traveling in the $x$-direction in air was observed to have a differential pressure $p(x,t) = 10 \text{ N/m}^2$ at $x = 0$ and $t = 50 \mu\text{s}$. If the reference phase of $p(x,t)$ is $36^\circ$, find a complete expression for $p(x,t)$. The velocity of sound in air is $330 \text{ m/s}$.

P2. Problem 1.2:

**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 1.3:

**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:

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 $60^\circ$. 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."
P5. Problem 1.6:

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:

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

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

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:

![Incident Wave](image)

P7. Problem 1.8:

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. Problem 1.9

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

(a) \( y(x,0) = 0 \) at \( x = 0 \),
(b) \( y(x,0) = 0 \) at \( x = 7.5 \text{ cm} \). Notice difference from problem in textbook

P9. Problem 1.14

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?

P10. Problem 1.26

Find the phasors of the following time functions:

(a) \( v(t) = 3 \cos(\omega t - \pi/3) \text{ (V)} \), Amplitude is 9 in 7/E and 6/E of textbook
(b) \( v(t) = 12 \sin(\omega t + \pi/4) \text{ (V)} \),
(c) \( i(x,t) = 2e^{-3t} \sin(\omega t + \pi/6) \text{ (A)} \), Again, amplitude different in newer versions
(d) \( i(t) = -2 \cos(\omega t + 3\pi/4) \text{ (A)} \),
(e) \( i(t) = 4 \sin(\omega t + \pi/3) + 3 \cos(\omega t - \pi/6) \text{ (A)} \).

P11. Problem 1.27

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

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