EE381 Homework 1 Problems

Chapter 1

Problem 1.1 A 2-kHz sound wave traveling in the x-direction in air was observed to have a differential pressure $p(x,t) = 10$ 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.

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.

*** Please use software to do the plotting for Prob. 1.2**

Problem 1.5 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 $x = 2\lambda$.

Problem 1.11 Given two waves characterized by

$$y_1(t) = 3\cos\omega t,$$
$$y_2(t) = 3\sin(\omega t + 36°),$$

does $y_2(t)$ lead or lag $y_1(t)$, and by what phase angle?

Problem 1.14 Evaluate each of the following complex numbers and express the result in rectangular form:

(b) $z_2 = \sqrt{3}\, e^{j3\pi/4}$,

(d) $z_4 = j^3$,

Problem 1.16 If $z = -2 + j4$, determine the following quantities in polar form:

(b) z^3,

Problem 1.21 A voltage source given by $v_s(t) = 25\cos(2\pi \times 10^3 t - 30°)$ (V) is connected to a series RC load as shown in Fig. 1-19. If $R = 1$ MΩ and $C = 200$ pF, obtain an expression for $v_c(t)$, the voltage across the capacitor.

*** The RC circuit is in Fig. 1-19 of the 5th edition and in Fig. 1-20 of the 6th & 7th editions**

Problem 1.23 Find the instantaneous time sinusoidal functions corresponding to the following phasors:

(b) $\widetilde{V} = j6e^{-j\pi/4}$ (V),

(c) $\widetilde{I} = (6 + j8)$ (A),

Problem 1.24 A series RLC circuit is connected to a generator with a voltage $v_s(t) = V_0 \cos(\omega t + \pi/3)$ (V).

(a) Write down the voltage loop equation in terms of the current $i(t)$, R, L, C, and $v_s(t)$.

(b) Obtain the corresponding phasor-domain equation.

(c) Solve the equation to obtain an expression for the phasor current $\widetilde{I}$.

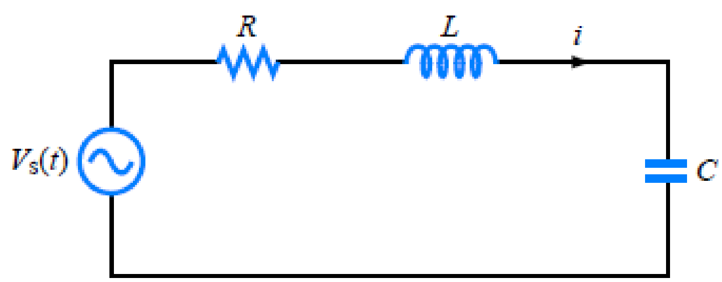

Figure P1.24: RLC circuit.

Exercise problems (for exercise only – don't need to be turned in)

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?

Problem 1.6 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 down 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 $-2\lambda \leq x \leq 0$ at $\omega t = \pi/4$ and at $\omega t = \pi/2$.

Problem 1.12 The voltage of an electromagnetic wave traveling on a transmission line is given by $v(z,t) = 5e^{-\alpha z}\sin(4\pi \times 10^9 t - 20\pi z)$ (V), 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 1 V. Find α.

Problem 1.17 Find complex numbers $t = z_1 + z_2$ and $s = z_1 - z_2$, both in polar form, for each of the following pairs:

(c) $z_1 = 3\angle 30^\circ$, $z_2 = 3\angle -30^\circ$,

(d) $z_1 = 3\angle 30^\circ$, $z_2 = 3\angle -150^\circ$.

Problem 1.14 Evaluate each of the following complex numbers and express the result in rectangular form:

(e) $z_5 = j^{-4}$,

(g) $z_7 = (1 - j)^{1/2}$.