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 $t = 50\,\mu$s. 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 1.8 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 $|y_s|$?

Problem 1.9 Give expressions for $y(x,t)$ for a sinusoidal wave traveling along a string in the negative x-direction, given that $y_{max} = 40$ cm, $\lambda = 30$ cm, $f = 10$ Hz, and

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

(b) $y(x,0) = 0$ at $x = 3.75$ cm.

Problem 1.13 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 2 V. Find α.

Problem 1.16 Evaluate each of the following complex numbers and express the result in rectangular form:

(a) $z_1 = 8e^{j\pi/3}$

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

(c) $z_3 = 2e^{-j\pi/2}$

(d) $z_4 = j^3$

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

(f) $z_6 = (1-j)^3$

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

Problem 1.19 If $z = -2 + j4$, determine the following quantities in polar form:

(a) $1/z$,

(b) z^3,

(c) $|z|^2$,

(d) $\mathfrak{Im}\{z\}$,

(e) $\mathfrak{Im}\{z^*\}$.

Problem 1.21 Complex numbers z_1 and z_2 are given by

$$z_1 = 5\angle -60^\circ$$
$$z_2 = 4\angle 45^\circ.$$

(a) Determine the product $z_1 z_2$ in polar form.

(b) Determine the product $z_1 z_2^*$ in polar form.

(c) Determine the ratio z_1/z_2 in polar form.

(d) Determine the ratio z_1^*/z_2^* in polar form.

(e) Determine $\sqrt{z_1}$ in polar form.

Problem 1.26 Find the phasors of the following time functions:

(a) $v(t) = 9\cos(\omega t - \pi/3)$ (V)
(b) $v(t) = 12\sin(\omega t + \pi/4)$ (V)
(c) $i(x,t) = 5e^{-3x}\sin(\omega t + \pi/6)$ (A)
(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)

Problem 1.27 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)

Problem 1.28 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 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 $\tilde{I}$.