

$$1.1 (a) z = 0 + j10 = 10e^{j\pi/2}$$

$$(b) z = 5 + j0 = 5e^{j0}$$

$$(c) z = (-10, -10) = -10 - j10 = 10\sqrt{2}e^{j\frac{5\pi}{4}}$$

$$(d) z = 1 + j = \sqrt{2}e^{j\pi/4}$$

$$(e) z = \frac{1}{\sqrt{3}} - j = 1.15e^{-j1.05}$$

$$(f) z = -2j = 2e^{-j\pi/2}$$

$$1.2 (a) z = 2e^{-j3\pi/4} = -\sqrt{2} - j\sqrt{2}$$

$$(b) z = 10e^{j\pi/2} = j10$$

$$(c) z = 4\angle\frac{\pi}{3} = 2 + j3.46$$

$$(d) z = 10\angle-7.5\pi \text{ reduce to } \angle \pm\pi$$

$$z = 10\angle 0.5\pi = j10$$

$$1.3 (a) z_1^* = (3 + j3)^* = 3 - j3 = 4.243e^{-j\pi/4}$$

$$(b) jz_2 = j(2e^{-j3\pi/4}) = e^{j\pi/2} 2e^{-j3\pi/4} = 2e^{-j\pi/4} = \sqrt{2} - j\sqrt{2}$$

$$1.3 (c) z_2/z_1 = \frac{2e^{-j3\pi/4}}{3+j3} = \frac{2e^{-j3\pi/4}}{3\sqrt{2}e^{j\pi/4}} = \frac{\sqrt{2}}{3}e^{-j\pi} = -\frac{\sqrt{2}}{3}$$

$$(d) z_2^2 = (2e^{-j3\pi/4})^2 = 4e^{-j6\pi/4} = 4e^{-j3\pi/2} = j^4$$

$$(e) z_1^{-1} = \frac{1}{3+j3} = \frac{3-j3}{3^2+3^2} = \frac{3-j3}{18} = \frac{1}{6} - j\frac{1}{6} = \frac{\sqrt{2}}{6}e^{-j\pi/4}$$

$$(f) z_1 z_2 = (3+j3)(2e^{-j3\pi/4}) = 3\sqrt{2}e^{j\pi/4} 2e^{-j3\pi/4} = 6\sqrt{2}e^{-j2\pi/4} = 6\sqrt{2}e^{-j\pi/2} = -j6\sqrt{2}$$

$$(g) z_1 + z_2^* = (3+j3) + 2e^{j3\pi/4} = 3+j3 - \sqrt{2} + j\sqrt{2} = 1.5858 + j4.4142 = 4.69e^{j0.39\pi}$$

$$(h) |z_2|^2 = z_2 z_2^* = 2e^{-j3\pi/4} 2e^{j3\pi/4} = 2 \cdot 2 = 4$$

$$(i) z_2 + z_2^* = 2e^{-j3\pi/4} + 2e^{j3\pi/4} = 2\cos(-\frac{3\pi}{4}) + 2\cos(+\frac{3\pi}{4}) = 4\cos(\frac{3\pi}{4}) = \frac{4}{-\sqrt{2}} = -2.8284 = 2.828e^{j\pi}$$

$$1.4 (a) z = Ae^{j2\pi/3} \quad \operatorname{Re}[z^*] = A\cos(-\frac{2\pi}{3}) = -0.5A$$

$$(b) z = Ae^{j2\pi/3} \quad z - z^* = Ae^{j2\pi/3} - Ae^{-j2\pi/3} = A\cos\frac{2\pi}{3} + jA\sin\frac{2\pi}{3} - A\cos(-\frac{2\pi}{3}) - jA\sin(-\frac{2\pi}{3})$$

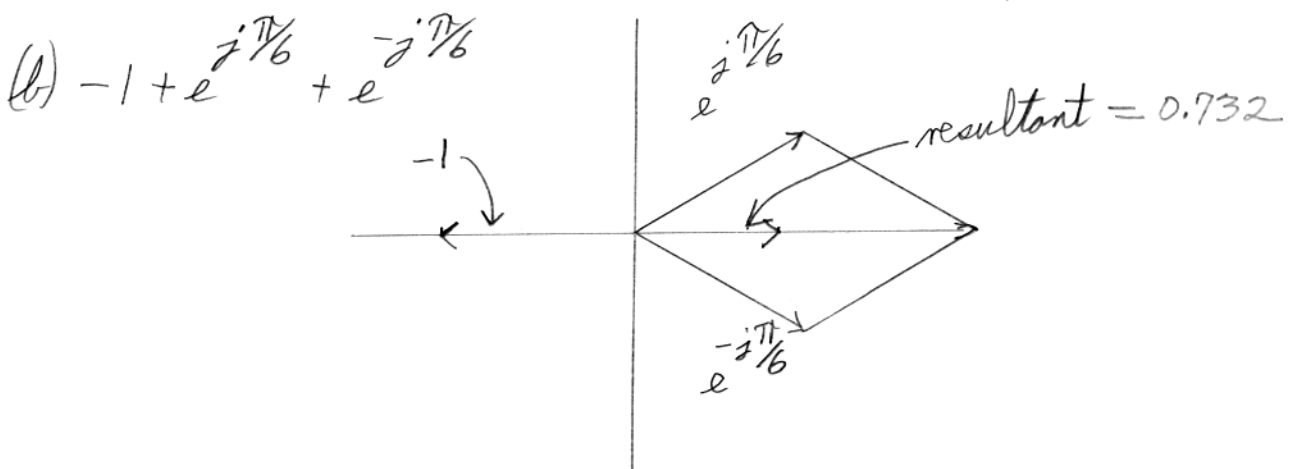
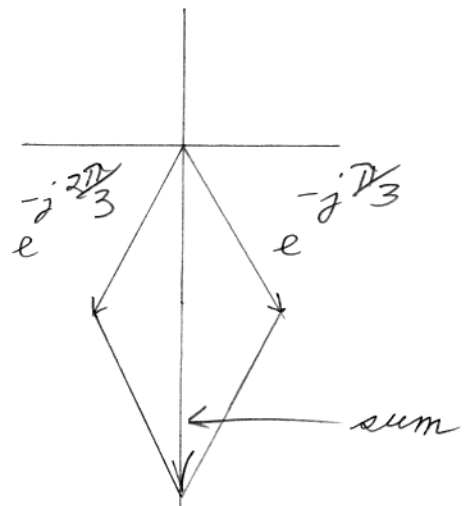
$$\begin{aligned} 1.4 (b) (cont.) &= 0 + j2A \sin\left(+\frac{2\pi}{3}\right) = j2A \frac{\sqrt{3}}{2} \\ &= j\sqrt{3}A \end{aligned}$$

$$\begin{aligned} (c) \operatorname{Im}\left[j10e^{-j\phi}\right] &= \operatorname{Im}\left[10e^{j\frac{\pi}{2}} e^{-j\phi}\right] = \operatorname{Im}\left[10e^{j(\frac{\pi}{2}-\phi)}\right] \\ &= 10\sin\left(\frac{\pi}{2}-\phi\right) = -10\sin\left(\phi-\frac{\pi}{2}\right) = 10\cos\phi \end{aligned}$$

$$(d) z = \alpha + j\alpha = \sqrt{2}\alpha e^{j\frac{\pi}{4}}$$

$$(e) \frac{|z|}{z} = \frac{|Ae^{j\frac{2\pi}{3}}|}{Ae^{j\frac{2\pi}{3}}} = \frac{A}{A} e^{-j\frac{2\pi}{3}} = e^{-j\frac{2\pi}{3}}$$

$$\begin{aligned} 1.5 (a) z_a &= e^{-j\frac{2\pi}{3}} + e^{-j\frac{\pi}{3}} \\ &= -j\sqrt{3} = \sqrt{3}e^{-j\frac{\pi}{2}} \end{aligned}$$



$$1.5(c) \quad z_a = \exp(-j * 2 * \pi / 3) + \exp(-j * \pi / 3)$$

$$\text{abs}(z_a)$$

$$\text{angle}(z_a)$$

$$z_b = -1 + \exp(j * \pi / 6) + \exp(-j * \pi / 6)$$

$$\text{abs}(z_b)$$

$$\text{angle}(z_b)$$

1.6 The period, $T = 0.04 \text{ sec}$ $A = 20$

Therefore $f_0 = \frac{1}{T} = 25.0 \text{ Hz}$, $\omega_0 = 2\pi f_0 = 50\pi \text{ rad/sec}$.

$$t_m = 0.01 \text{ sec.} \quad \phi = -\omega t_m = -50\pi(0.01) = -0.5\pi$$

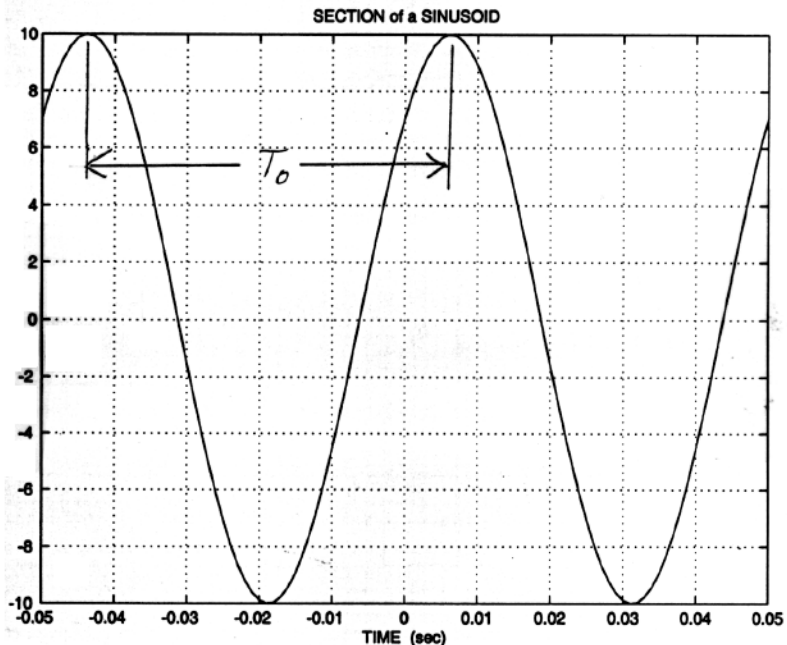
$$1.7 \text{ amplitude} = \frac{10 |1-j|}{\sqrt{2}} = \frac{10\sqrt{2}}{\sqrt{2}} = 10$$

$$\phi = \angle(1-j) = -\frac{\pi}{4}$$

$$A = 10$$

$$T_0 = \frac{1}{F_0} = \frac{1}{20}$$

$$= 0.05 \text{ sec.}$$



1.8 (a) $A = 20$ $T_0 = 0.2 \text{ sec.}$ $f_0 = 5 \text{ Hz.}$
 $\omega_0 = 10\pi \text{ rad/sec.}$
 $t_m = 0.1 \text{ sec.}$ $\phi = -\omega t_m = -\pi \text{ rad.}$

$$x(t) = 20 \cos(10\pi t - \pi)$$

(b) $z(t) = 20 e^{j10\pi t} e^{-j\pi}$ $Z = 20 e^{-j\pi}$

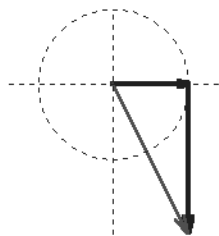
(c) $y(t) = 5x(t-0.1) = 100 \cos(10\pi(t-0.1) - \pi)$
 $= 100 \cos(10\pi t - \pi - \pi) = 100 \cos(10\pi t)$
(easy plot)

1.9 (a) $x_a(t) = \cos(11\pi t) + 2 \sin(11\pi t)$

$$= \cos(11\pi t) + 2 \cos(11\pi t - \pi/2)$$

as phasors: $1 e^{j0} + 2 e^{-j\pi/2} = 1 - j2 = 2.24 e^{-j1.1}$

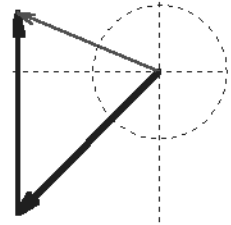
$$x_a(t) = 2.24 \cos(11\pi t - 1.1)$$



$$(b) x_b(t) = 3 \cos(245t - \frac{3\pi}{4}) + 3 \cos(245t + \frac{\pi}{2})$$

as phasors $3e^{-j\frac{3\pi}{4}} + 3e^{j\frac{\pi}{2}} = 2.30e^{j2.75}$

$$x_b(t) = 2.30 \cos(245t + 2.75)$$



$$1.9(c) x_c(t) = \cos(41t + 11\pi) + \sqrt{2} \sin(41t + \frac{\pi}{4}) + \sqrt{2} \sin(41t - \frac{\pi}{4})$$

$$= \cos(41t + \pi) + \sqrt{2} \cos(41t + \frac{\pi}{4} - \frac{\pi}{2})$$

$$+ \sqrt{2} \cos(41t - \frac{\pi}{4} - \frac{\pi}{2})$$

as phasors:

$$1e^{j\pi} + \sqrt{2}e^{-j\frac{\pi}{4}} + \sqrt{2}e^{-j\frac{3\pi}{4}} = 2.24e^{-j2.03}$$

$$x_c(t) = 2.24 \cos(41t - 2.03)$$

