3.1 (a) $6e^{j\pi} = -6$ and

$$3e^{j2\pi/3}e^{-j60\pi t} + 3e^{-j2\pi/3}e^{j60\pi t} = 6\cos(60\pi t - 2\pi/3)$$

$$\boxed{x(t) = -6 + 6\cos(60\pi t - 2\pi/3) = -6\left(1 + \cos(60\pi t + \pi/3)\right)}$$

(b) $x^3(t) = -216\left(1 + \cos(60\pi t + \pi/3)\right)^3$ let $\theta = 60\pi t + \pi/3$

$$= -216\left(1 + 3\cos\theta + 3\cos^2\theta + \cos^3\theta\right)$$

$$\cos^2\theta = \frac{1}{2} + \frac{1}{2}\cos 2\theta$$

$$\cos^3\theta = \cos\theta\left(\frac{1}{2} + \frac{1}{2}\cos 2\theta\right)$$

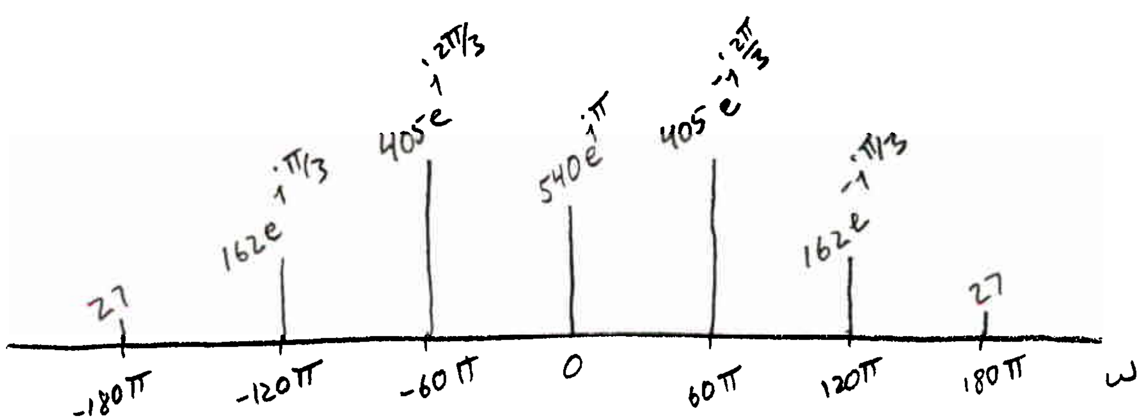
$$= \frac{1}{2}\cos\theta + \frac{1}{2}\cos\theta\cos 2\theta$$

$$= \frac{1}{2}\cos\theta + \frac{1}{4}\cos(2\theta - \theta) + \frac{1}{4}\cos(2\theta + \theta)$$

$$= \frac{3}{4}\cos\theta + \frac{1}{4}\cos(3\theta)$$

$$= -216\left(1 + 3\cos\theta + \frac{3}{2} + \frac{3}{2}\cos(2\theta) + \frac{3}{4}\cos\theta + \frac{1}{4}\cos(3\theta)\right)$$

$$\boxed{x^3(t) = -54\left(10 + 15\cos(60\pi t + \pi/3) + 6\cos\left(120\pi t + \frac{2\pi}{3}\right) - \cos(180\pi t)\right)}$$



3.1 (c) $z(t) = 2(-6)\left(1 + \cos(60\pi t + \pi/3)\right)\left(\cos(200\pi t - \pi/4)\right)$

$$= -12\left(\cos(200\pi t - \pi/4) + \cos(60\pi t + \pi/3)\cos(200\pi t - \pi/4)\right)$$

$$= 12\cos\left(200\pi t + 3\pi/4\right) - 6\cos\left(140\pi t - 7\pi/12\right) - 6\cos\left(260\pi t + \pi/12\right)$$

3.2 (a)

$$x(t) = 3\left(\frac{e^{j150\pi t} + e^{-j150\pi t}}{2}\right)\left(\frac{e^{j200\pi t} - e^{-j200\pi t}}{2j}\right)$$

$$= -\frac{3j}{4}\left(e^{j350\pi t} + e^{-j350\pi t} + e^{j50\pi t} - e^{-j50\pi t}\right)$$

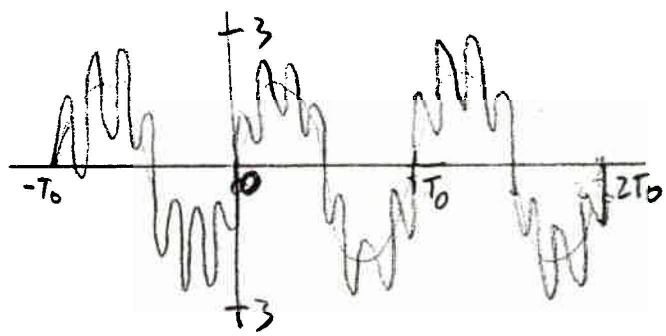
(b)

$$x(t) = \frac{3}{2}\sin(350\pi t) + \frac{3}{2}\sin(50\pi t)$$

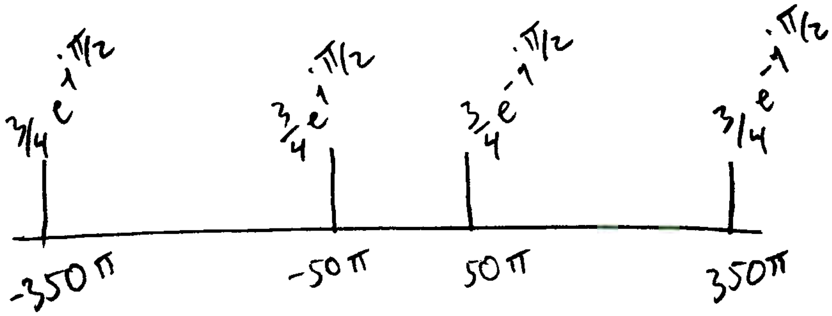
$$= \frac{3}{2}\cos(350\pi t - \pi/2) + \frac{3}{2}\cos(50\pi t - \pi/2)$$

(c) The GCF of 350π & 50π is $50\pi \rightarrow f = 25$

$T_0 = \frac{1}{25}$



(d)



3.3 (a) $x(t) = \mathcal{R}_e\left\{ e^{j(2\pi(259)t + \pi/4)} + e^{j(2\pi(262)t - 3\pi/4)} + e^{j(2\pi(265)t + \frac{\pi}{4})} \right\}$ (1)

$= \mathcal{R}_e\left\{ \hat{e}(t) e^{j(2\pi(262)t + \phi)} \right\}$ (2)

since the terms in the first expression are all complex exponentials, we assume that $\hat{e}(t)$ is also -

let $\hat{e}(t) = e^{j(2\pi f_1 t + \psi_1)} + e^{j(2\pi f_2 t + \psi_2)} + e^{j(2\pi f_3 t + \psi_3)}$

then eq (2) becomes

$\mathcal{R}e\left\{ e^{j(2\pi(262+f_1)t + \phi + \psi_1)} + e^{j(2\pi(262+f_2)t + \phi + \psi_2)} + e^{j(2\pi(262+f_3)t + \phi + \psi_3)} \right\}$

which matches (1) if

$f_1 = -3, \quad \psi_1 + \phi = \frac{\pi}{4}$

$f_2 = 0, \quad \psi_2 + \phi = -3\pi/4$

$f_3 = 3, \quad \psi_3 + \phi = \frac{\pi}{4}$

we now have 3 equations and 4 unknowns but we simplify by assuming $\phi = \phi_2$ or $\phi = \phi_2 + \pi$ to make the DC term real

$\phi = -3\pi/4, \quad \psi_1 = \pi, \quad \psi_2 = 0, \quad \psi_3 = \pi$

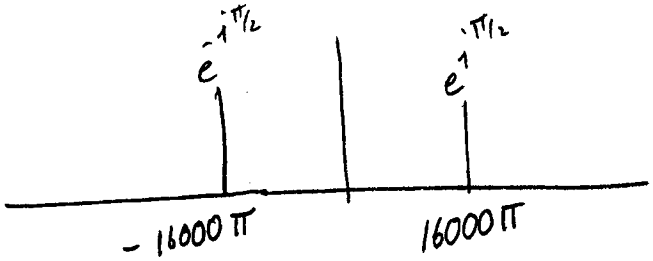
-or- $\phi = \pi/4, \quad \psi_1 = 0, \quad \psi_2 = \pi, \quad \psi_3 = 0$

so $e(t) = 1 - 2\cos(2\pi(3)t)$

or $e(t) = 2\cos(2\pi(3)t) - 1$

(b) $f_e = 3\text{ Hz}$, $\boxed{T = 1/3\text{ s}}$

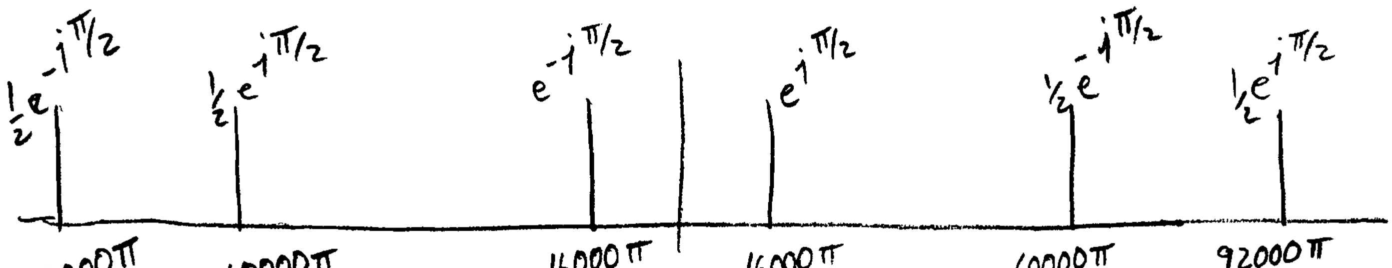
3.4 (a)



(b) $x_s(t) = x_d(t) = x_L(t) = 2\cos(2\pi(8000)t + \pi/2)$

$$x_i(t) = x_L(t) + x_L(t)\cos(2\pi(38000)t)$$

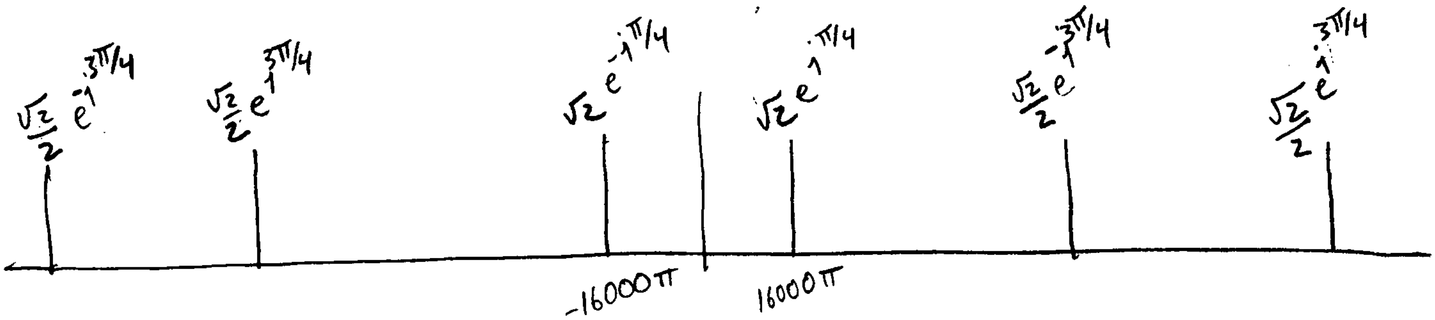
$$= 2\cos(2\pi(8000)t + 0.5\pi) + \cos(2\pi(30000)t - 0.5\pi)$$
$$+ \cos(2\pi(46000)t + 0.5\pi)$$



(c) $x_s(t) = 2\sqrt{2}\cos(\omega t + \pi/4)$ where $\omega = 2\pi 8000$

$x_d(t) = 2\sqrt{2}\cos(\omega t + 3\pi/4)$

The same frequencies are present as in (b) but with different phases and amplitudes.



3.5 (P.3.19 from text)

(a) $\leftrightarrow$ (3)

(b) $\leftrightarrow$ (5)

(c) $\leftrightarrow$ (1)

(d) $\leftrightarrow$ (2)

(e) $\leftrightarrow$ (4)