

# HW #3 ECE 2025 Spring 2003

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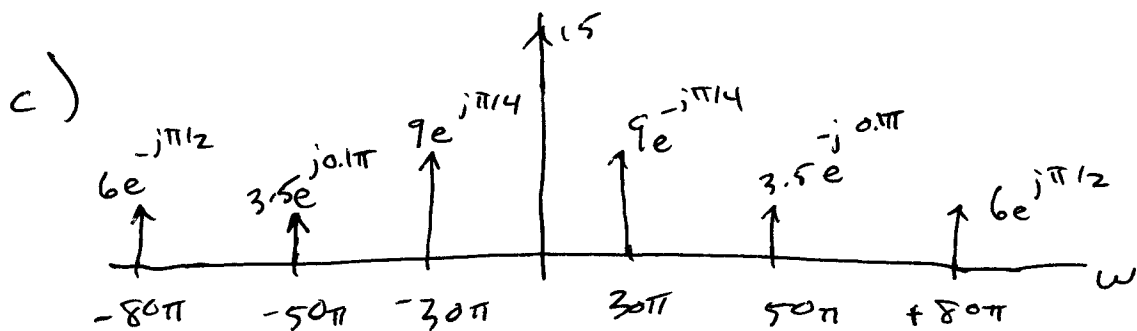
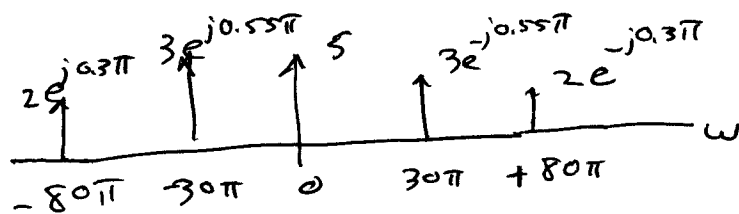
3.1 a) 
$$x(t) = 5 + 2 \left( e^{-j\pi/2} e^{j(80\pi)t} + e^{j\pi/2} e^{j(80\pi)t} \right) + 3 \left( e^{j\pi/4} e^{-j(30\pi)t} + e^{-j\pi/4} e^{j(30\pi)t} \right)$$

$$= 5 + 4 \cos(80\pi t + \pi/2) + 6 \cos(30\pi t - \pi/4)$$

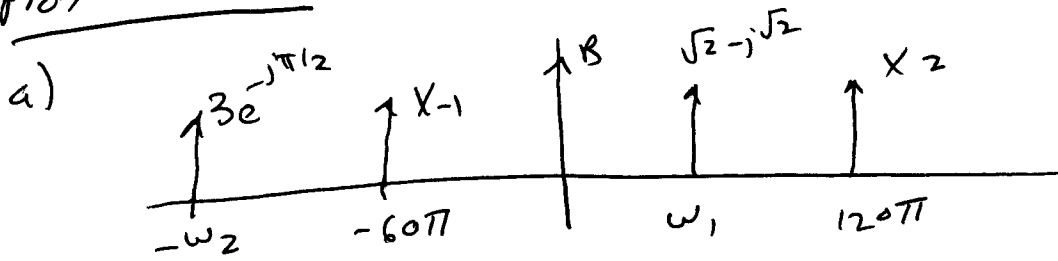
b) 
$$x(t-0.01) = 5 + 4 \cos(80\pi(t-0.01) + \pi/2) + 6 \cos(30\pi(t-0.01) - \pi/4)$$

$$= 5 + 4 \cos(80\pi t - 0.8\pi + \pi/2) + 6 \cos(30\pi t - 0.3\pi - \pi/4)$$

$$= 5 + 4 \cos(80\pi t - 0.3\pi) + 6 \cos(30\pi t - 0.55\pi)$$



# Problem 3.2



a)  $X_1 = (\sqrt{2} - j\sqrt{2})^* = (\sqrt{2} + j\sqrt{2}) = 2e^{j\pi/4}$

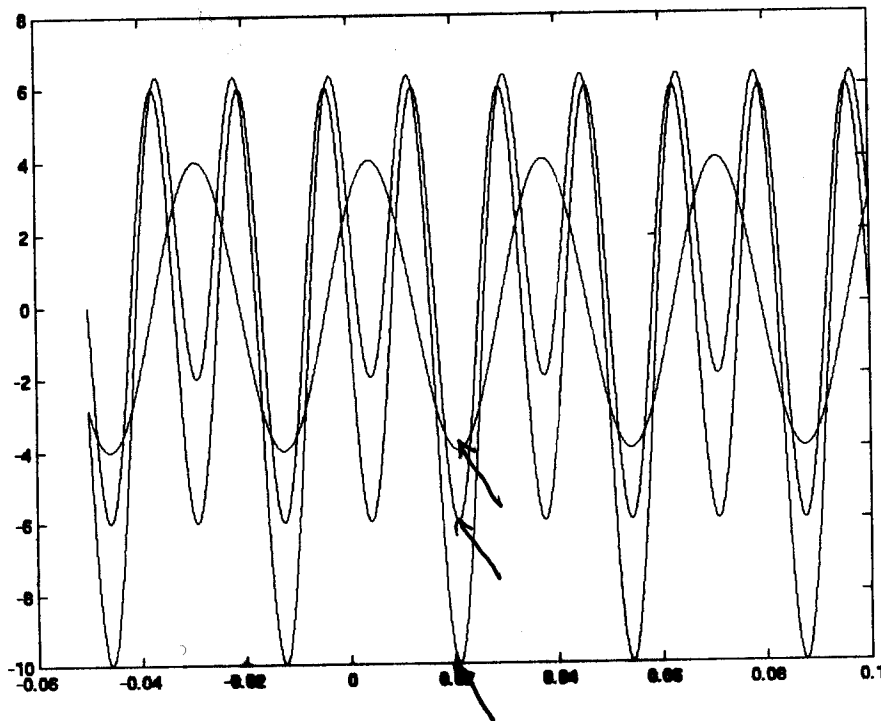
$w_2 = 120\pi$

$X_2 = (3e^{-j\pi/2})^* = 3e^{j\pi/2}$

$w_1 = 60\pi$

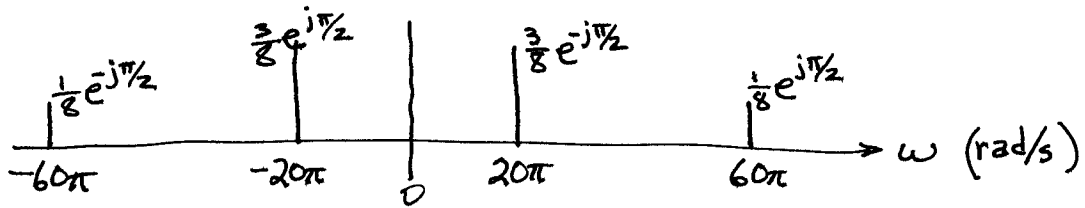
b)  $x(t) = B + 6\cos(120\pi t + \pi/2) + 4\cos(60\pi t - \pi/4)$

c) Find where  $x(t)$  is min  $\rightarrow$  note min of both  $6\cos(\ )$  and  $4\cos(\ )$  terms coincide:  $B = 10$



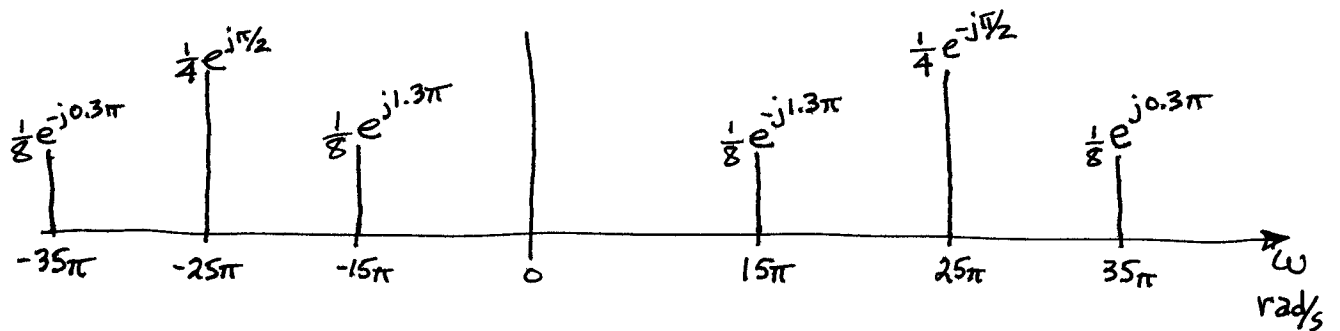
### Prob 3.3

$$\begin{aligned}
 (a) \quad x(t) &= \sin^3(20\pi t) \\
 &= \left( \frac{1}{2j} e^{j20\pi t} - \frac{1}{2j} e^{-j20\pi t} \right)^3 \\
 &= \frac{1}{8j^3} e^{j60\pi t} - \frac{3}{8j^3} e^{j20\pi t} + \frac{3}{8j^3} e^{-j20\pi t} - \frac{1}{8j^3} e^{-j60\pi t} \\
 &= \frac{1}{8} e^{j\pi/2} e^{j60\pi t} + \frac{3}{8} e^{-j\pi/2} e^{j20\pi t} + \frac{3}{8} e^{j\pi/2} e^{-j20\pi t} + \frac{1}{8} e^{-j\pi/2} e^{-j60\pi t}
 \end{aligned}$$



$$\begin{aligned}
 (b) \quad y(t) &= \cos^2(5\pi t + 0.4\pi) \sin(25\pi t) \\
 &= \left( \frac{1}{2} e^{j0.4\pi} e^{j5\pi t} + \frac{1}{2} e^{-j0.4\pi} e^{-j5\pi t} \right)^2 \left( \frac{1}{2j} e^{j25\pi t} - \frac{1}{2j} e^{-j25\pi t} \right) \\
 &= \left( \frac{1}{4} e^{j0.8\pi} e^{j10\pi t} + \frac{1}{2} + \frac{1}{4} e^{-j0.8\pi} e^{-j10\pi t} \right) \left( \frac{1}{2j} e^{j25\pi t} - \frac{1}{2j} e^{-j25\pi t} \right) \\
 &= \frac{1}{8j} e^{j0.8\pi} e^{j35\pi t} + \frac{1}{4j} e^{j25\pi t} + \frac{1}{8j} e^{-j0.8\pi} e^{j15\pi t} \dots \\
 &\quad - \frac{1}{8j} e^{j0.8\pi} e^{-j15\pi t} - \frac{1}{4j} e^{-j25\pi t} - \frac{1}{8j} e^{-j0.8\pi} e^{-j35\pi t}
 \end{aligned}$$

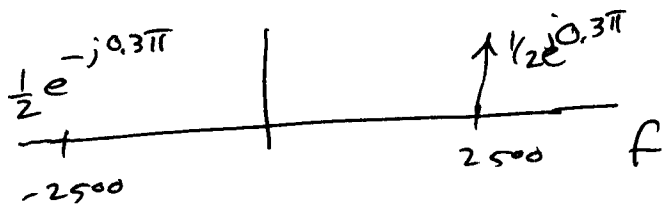
Since  $1/j = -j = e^{-j\pi/2}$  and  $-1/j = j = e^{j\pi/2}$



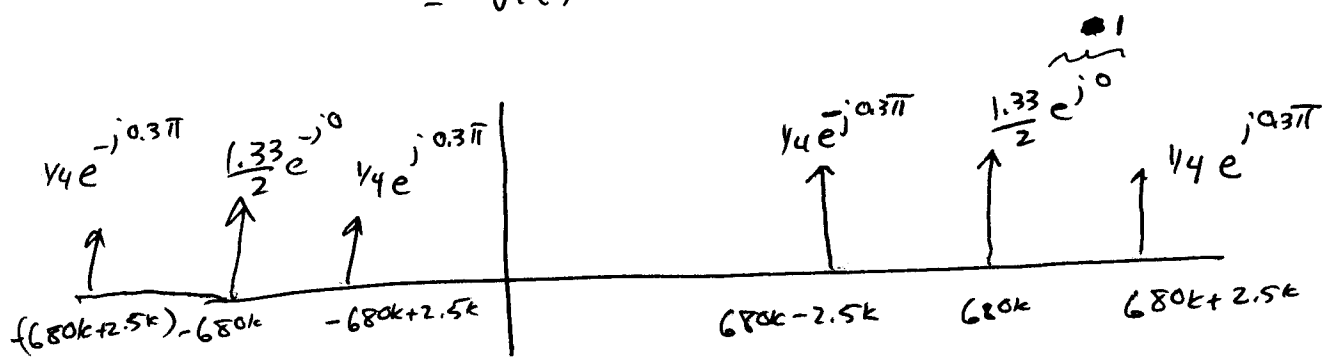
3.4

$$x(t) = (v(t) + A) \cos(2\pi(680k)t)$$

a)  $v(t) = \cos(2\pi(2500)t + 0.3\pi)$



b)  $x(t) = (v(t) + A) \cos(2\pi(680k)t)$   
 $= v(t) \cos(2\pi(680k)t) + 1.33 \cos(2\pi(680k)t)$



c) If carrier goes to 990k Hz  $\rightarrow$  entire diagram in b) shifts up to 990k Hz instead of 680k Hz. Everything else stays same.

3.5

a) 2  $x(t) = 3 \cos(3\pi t + \pi) = -3 \cos(3\pi t)$

b) 5  $x(t) = 3 \cos(2.4\pi t - \pi/4) + 3 \cos(4\pi t + \pi)$

c) 3  $x(t) = 2 + 3 \cos(2.4\pi t + \pi/2)$

d) 4  $x(t) = 3 \cos(1.2\pi t - \pi/4) + 3 \cos(6\pi t + \pi)$

e) 1  $\rightarrow x(t) = 2 + 3 \cos(2.4\pi t - \pi/4)$