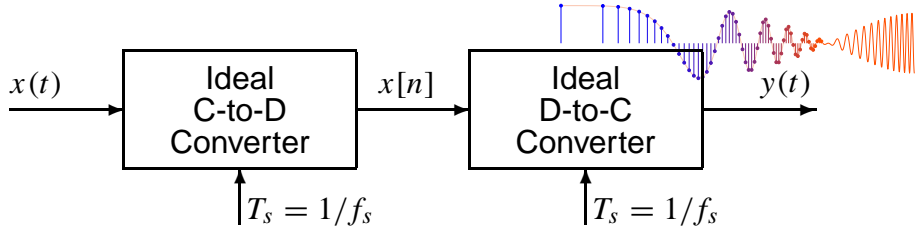


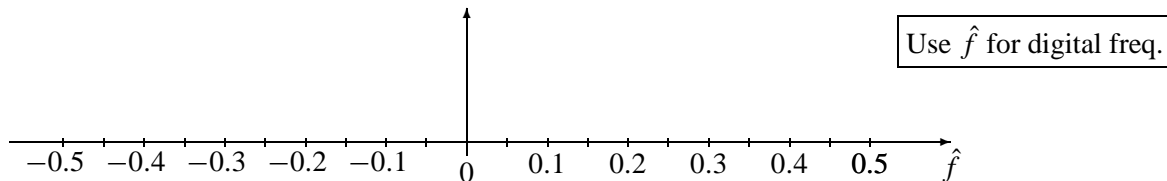
PROBLEM:



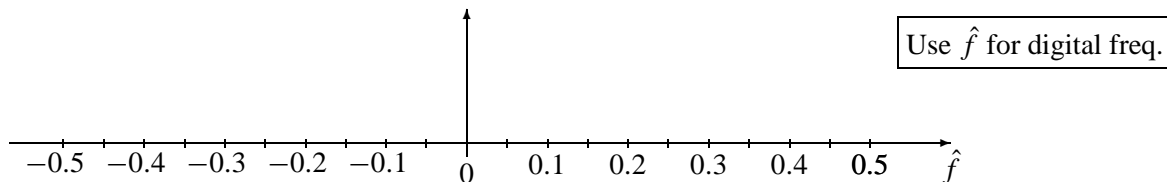
Suppose that the continuous-time input $x(t)$ to the above system is given as

$$x(t) = \cos(16000\pi t) + \cos(9000\pi t) + \cos(7000\pi t) + \cos(4000\pi t) + \cos(1000\pi t)$$

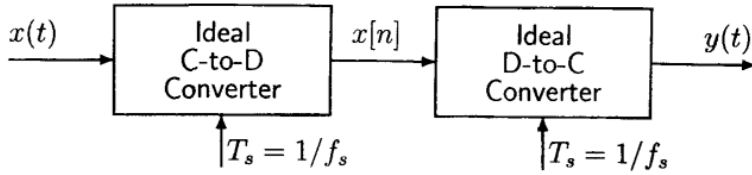
- (a) What is required such that no aliasing occurs for $x(t)$?
- (b) Given that $f_s = 10000$ samples/second, the frequency spectrum for $x[n]$.



- (c) Given that $f_s = 3000$ samples/second, the frequency spectrum for $x[n]$.



- (d) Given that $x(t) = \cos(26000\pi t + \pi/3) + \cos(16000\pi t + \pi/3) + \cos(4000\pi t - \pi/3)$ and $f_s = 10000$ samples/second, write a simplified expression for the in terms of cosine functions.



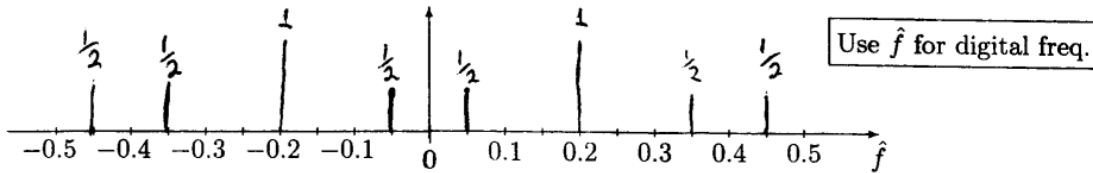
Suppose that the continuous-time input $x(t)$ to the above system is given as

$$x(t) = \cos(16000\pi t) + \cos(9000\pi t) + \cos(7000\pi t) + \cos(4000\pi t) + \cos(1000\pi t)$$

(a) What **sampling rate** is required such that no aliasing occurs for $x(t)$? $f_s = 16000 \text{ Hz}$

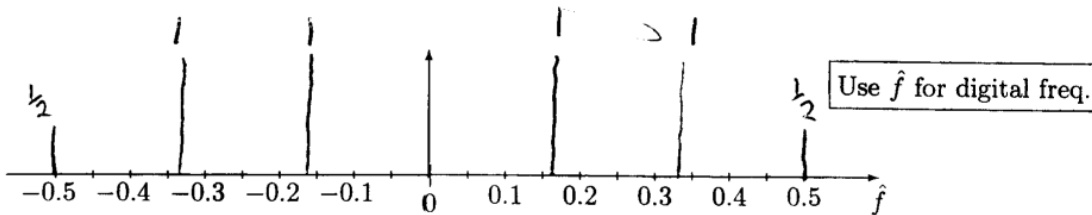
(b) Given that $f_s = 10000$ samples/second, **plot** the frequency spectrum for $x[n]$.

$$\frac{8000}{10000} = 0.8 \Rightarrow 0.2 \quad \frac{4500}{10000} = 0.45 \quad \frac{3500}{10000} = 0.35 \quad \frac{2000}{10000} = 0.2 \quad \frac{500}{10000} = 0.05$$



(c) Given that $f_s = 3000$ samples/second, **plot** the frequency spectrum for $x[n]$.

$$\frac{8000}{3000} = \frac{8}{3} \Rightarrow \frac{1}{3} \Rightarrow \frac{1}{3} \quad \left| \quad \frac{4500}{3000} = \frac{4.5}{3} \Rightarrow \frac{1.5}{3} = \frac{1}{2} \quad \frac{3500}{3000} = \frac{3.5}{3} \Rightarrow \frac{1}{6} \quad \left| \quad \frac{2000}{3000} = \frac{2}{3} \Rightarrow \frac{1}{3} \quad \left| \quad \frac{500}{3000} = \frac{1}{6} \right. \right.$$



(d) Given that $x(t) = \cos(26000\pi t + \pi/3) + \cos(16000\pi t + \pi/3) + \cos(4000\pi t - \pi/3)$ and $f_s = 10000$ samples/second, write a simplified expression for the **output $y(t)$** in terms of cosine functions.

$$\frac{13000 \text{ Hz}}{10000} = 1.3 - 1 \Rightarrow 0.3 \Rightarrow 3000 \text{ Hz} \Leftarrow \text{aliasing}$$

$$\frac{8000 \text{ Hz}}{10000} = 0.8 - 1 \Rightarrow -0.2 \Rightarrow 0.2 \Rightarrow 2000 \text{ Hz} \Leftarrow \text{folding}$$

$$y(t) = \cos(2\pi(3000)t + \pi/3) + \cos(2\pi(2000)t - \pi/3) + \cos(2\pi(2000)t - \pi/3)$$

$$\therefore y(t) = \cos(6000\pi t + \pi/3) + 2 \cos(4000\pi t - \pi/3)$$