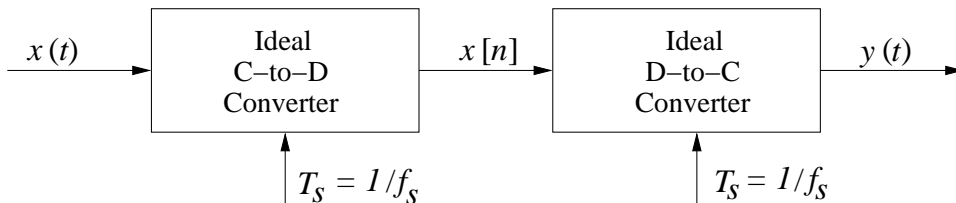


**PROBLEM:**



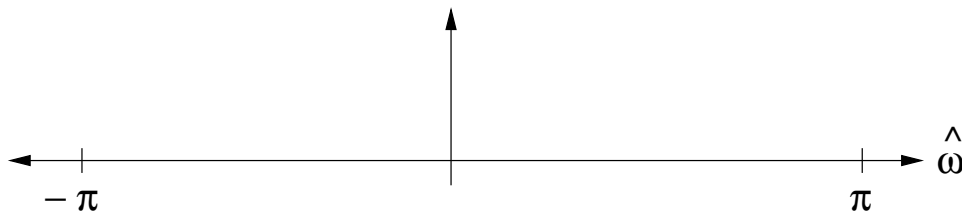
Shown in the figure above is an ideal C-to-D converter that samples  $x(t)$  with a sampling period  $T_s$  to produce the discrete-time signal  $x[n]$ . The ideal D-to-C converter then forms a continuous-time signal  $y(t)$  from the samples  $x[n]$ .

Let  $x(t) = 6 \cos(2\pi(8000)t) + 8 \sin(2\pi(6000)t)$

- (a) What is the minimum sampling rate such that  $y(t) = x(t)$ ?

$f_s =$

- (b) Sketch the digital spectrum of  $x[n]$  when  $f_s = 20000$  samples/sec. Carefully label the amplitudes and frequencies in your sketch.

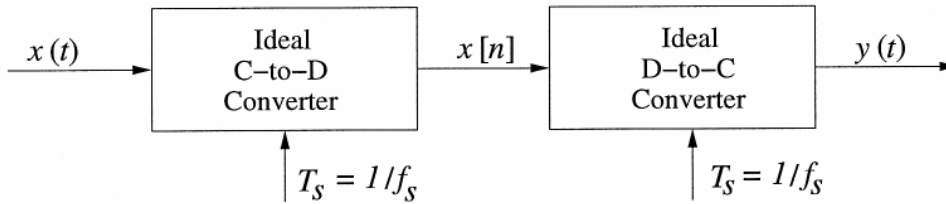


- (c) If we under-sample  $x(t)$ , aliases of the spectral components can appear in the baseband of the digital spectrum. What is the maximum sampling rate  $f_{s \max}$  such that the spectrum of  $x[n]$  will have a non-zero DC component?

$f_{s \max} =$

Determine the amplitude value for the DC component of  $x[n]$  at this sampling rate.

DC Value =



Shown in the figure above is an ideal C-to-D converter that samples  $x(t)$  with a sampling period  $T_s$  to produce the discrete-time signal  $x[n]$ . The ideal D-to-C converter then forms a continuous-time signal  $y(t)$  from the samples  $x[n]$ .

Let  $x(t) = 6 \cos(2\pi(8000)t) + 8 \sin(2\pi(6000)t) \leftarrow 8 \cos(2\pi(6000)t - \pi/2)$

(a) What is the minimum sampling rate such that  $y(t) = x(t)$ ?

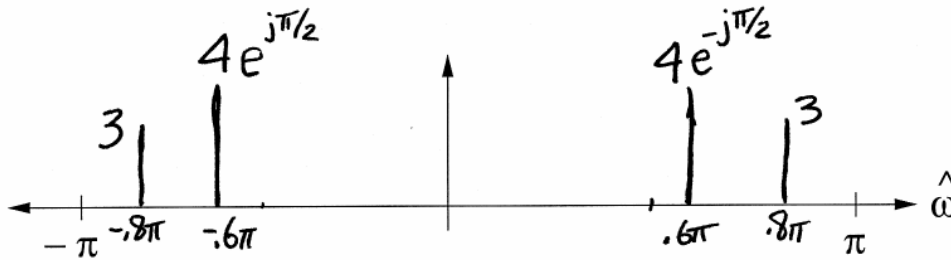
$$f_s = 16,000 \text{ Hz}$$

Sampling Thm  $\Rightarrow f_s \geq 2f_{\max}$   
 $f_{\max} = 8000 \text{ Hz}$

(b) Sketch the digital spectrum of  $x[n]$  when  $f_s = 20000$  samples/sec. Carefully label the amplitudes and frequencies in your sketch.

$$\hat{\omega}_1 = 2\pi \frac{8000}{20000} = 0.8\pi$$

$$\hat{\omega}_2 = 2\pi \frac{6000}{20000} = 0.6\pi$$



(c) If we under-sample  $x(t)$ , aliases of the spectral components can appear in the baseband of the digital spectrum. What is the maximum sampling rate  $f_{s\max}$  such that the spectrum of  $x[n]$  will have a non-zero DC component?

$$f_{s\max} = 8000 \text{ Hz}$$

Need  $\hat{\omega} = 2\pi$ . If  $f_s = 8000$ ,  $\hat{\omega} = 2\pi \frac{8000}{8000}$

Determine the amplitude value for the DC component of  $x[n]$  at this sampling rate.

$$\text{DC Value} = 6$$

At  $f_s = 8000 \text{ Hz}$ , the DC is  
 $6 \cos(2\pi \frac{8000n}{8000}) = 6 \cos(2\pi n) = 6$