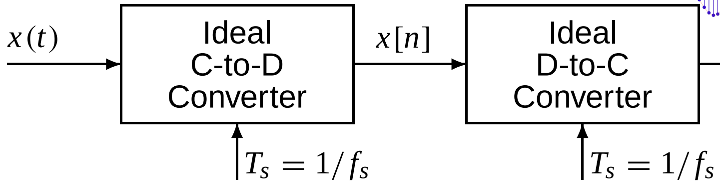
PROBLEM:



In all parts below, the sampling rates of the C/D and D/C converters are **equal,** and the input to the Ideal C/D converter is

$$x(t) = 2\cos(2\pi(50)t + \pi/2) + \cos(2\pi(150)t).$$

(a) If the output of the ideal D-to-C Converter is

$$y(t) = x(t) = 2\cos(2\pi(50)t + \pi/2) + \cos(2\pi(150)t),$$

what general statement can you make about the sampling frequency f_s in this case?

(b) If the sampling rate is $f_s = 250$ samples/sec., determine the discrete-time signal $x[n]$, and give an expression for $x[n]$ as a sum of cosines. *Make sure that all frequencies in your answer are positive and less than π radians.* Plot the spectrum of this signal over the range of frequencies $-\pi \le \hat{\omega} \le \pi$. Make a $\boxed{\text{plot}}$ for your answer, but label the frequency, amplitude and phase of each spectral component.

(c) If the output of the ideal D-to-C Converter is

$$y(t) = 2\cos(2\pi(50)t + \pi/2) + 1,$$

determine the value of the sampling frequency f_s. (Remember that the input $x(t)$ is as defined above.)

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Prentice Hall, Upper Saddle River, NJ 07458.

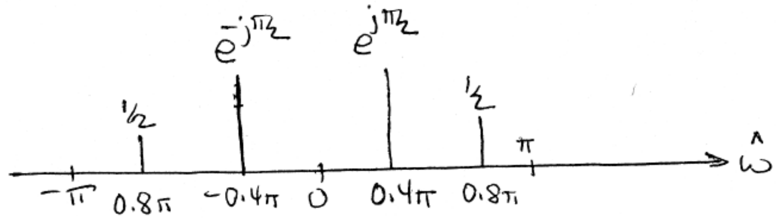
SOLUTION

(a) NO ALIASING $\Rightarrow f_s > 2(150) = 300$ SAMPLES/SEC

(b) $x[n] = x\left(\frac{n}{250}\right) = 2\cos\left(2\pi(50)\frac{n}{250} + \pi/2\right) + \cos\left(2\pi(150)\frac{n}{250}\right)$

$= 2\cos\left(0.4\pi n + \pi/2\right) + \cos\left(1.2\pi n\right)$

$= 2\cos\left(0.4\pi n + \pi/2\right) + \cos\left(0.8\pi n\right)$



(c) SINCE THE 50 Hz TERM IS UNCHANGED, THEN WE KNOW

$f_s > 2(50) = 100$ Hz.

HOWEVER, THE 150 Hz SINUSOID ALIASES TO 0 Hz.

$\Rightarrow f_s = 150$ SAMPLES/SEC.

WHY? FOR $f_s = 150$ Hz, WE HAVE $\hat{f} = \frac{150}{150} = 1$

WHICH ALIASES TO $\hat{f} = 1 - 1 = 0$.

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