Digital SignalProcessing

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Tutorial Questions/Lista de Exercícios - 2

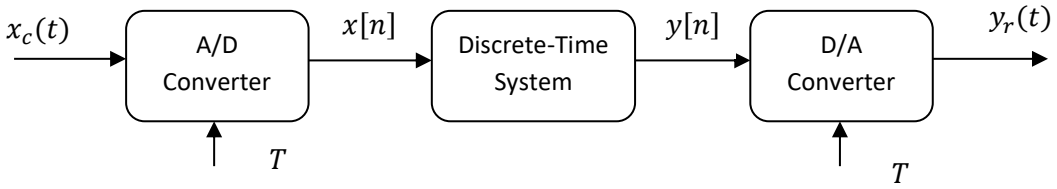
1. The continuous-time signal

$$x_c(t) = \sin(2\pi\ 100\ t)\,, \qquad -\infty < t < \infty$$

was sampled with sampling period $T = 1/400$ seconds to obtain a discrete-time signal $x[n]$.

a) What is the resulting discrete-time signal $x[n]$ and the sampling frequency F_s?
b) Write a Matlab routine to plot $x_c(t)$ sampled at 50 samples/second and at 500 samples/second.
c) Write a Matlab routine to show the sampled signal in the frequency domain.
d) Write a Matlab routine to reconstruct the signal $x_c(t)$ from the samples obtained in item b). (Hint: use the Sinc function)

2. Consider the system below with the discrete-time system being an ideal low-pass filter with cut-off frequency equal to $\frac{\pi}{8}$ radians/second.



a) If $x_c(t)$ is bandlimited to 5kHz, what is the maximum value of T that will avoid aliasing in the A/D converter?
b) If 1/T = 10 kHz, what will be the cut-off frequency of the effective continuous-time filter?

3. Consider the quantisation of a discrete-time signal $x[n]$ with a resolution Δ.

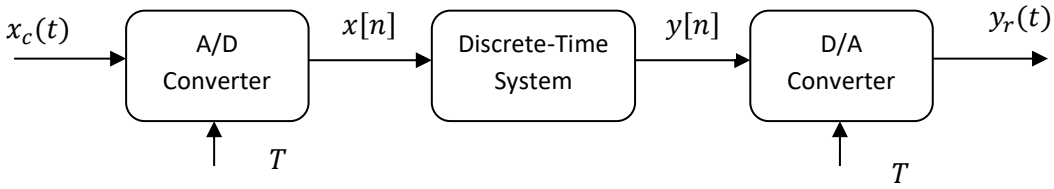
How many bits are required in the A/D converter?

a) When $x[n] = 6.35\cos\left(\frac{\pi n}{10}\right)$ and $\Delta = 0.1$.
b) When $x[n] = 2.5\cos\left(\frac{\pi n}{10}\right)$ and $\Delta = 0.2$.

What is the SQNR?

c) When $x[n] = \cos\left(\frac{\pi n}{10}\right)$ and $\Delta = 0.1$.
d) When $x[n] = 2.5\cos\left(\frac{\pi n}{10}\right)$ and $\Delta = 0.2$

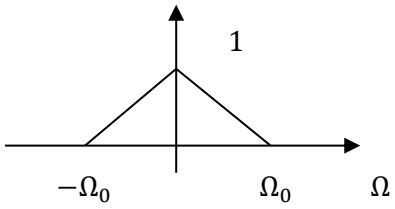
4. Consider the system described by



The input signal $x_c(t)$ has the Fourier transform shown in the figure below with $\Omega_0 = 2\pi(1000)$ radians/second. The discrete-time system is an ideal low-pass filter with frequency response described by

$$H(e^{j\omega}) = \begin{cases} 1, & |\omega| < \omega_c \\ 0. & \text{otherwise} \end{cases}$$

and



a) What is the minimum sampling rate $\mathrm{F}_s = 1/T$ such that no aliasing occurs in sampling the input?
b) Sketch the spectrum of the sampled signal at F_s.
c) If $\omega_c = \frac{\pi}{2}$, what is the minimum sampling rate such that $y_r(t) = x_c(t)$.