Exercise 4: We implement the following analog filter using a discrete filter.

$$x_a(t) \longrightarrow \boxed{\text{A/D}} \xrightarrow{x(n)} \boxed{h(n)} \xrightarrow{y(n)} \boxed{\text{D/A}} \longrightarrow y_a(t)$$

The sampling rate in the A/D and D/A is $8000 \frac{sam}{sec}$, and the impulse response is $h(n) = (-0.9)^n u(n)$.

a) What is the digital frequency in $x(n)$ if $x_a(t) = 10\cos(10{,}000\pi t)$?
b) Determine the steady-state output $y_a(t)$ if $x_a(t) = 10\cos(10{,}000\pi t)$.
c) Determine the steady-state output $y_a(t)$ if $x_a(t) = 5\sin(8000\pi t)$.
d) Find two other analog signals $x_a(t)$, with different analog frequencies, that will give the same steady-state output $y_a(t)$ when $x_a(t) = 10\cos(10{,}000\pi t)$ is applied.
e) To prevent aliasing, a prefilter would be required to process $x_a(t)$ before it passes to the A/D converter. What type of filter should be used, and what should be the largest cutoff frequency that would work for the given configuration?

Exercise 5: Consider the sequence $x(n) = (0.9)^n \cos\left(\frac{\pi n}{4}\right) u(n)$. Let

$$y(n) = \begin{cases} x\left(\frac{n}{2}\right) & n = 0, \pm 2, \pm 4, \cdots; \\ 0 & \text{otherwise.} \end{cases}$$

a) Show that the z-transform $Y(z)$ of $y(n)$ can be expressed in terms of the z-transform $X(z)$ of $x(n)$ as $Y(z) = X(z^2)$.
b) Determine $Y(z)$.
c) Using MATLAB, verify that the sequence $y(n)$ has the z-transform $Y(z)$.

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