PROBLEM:

Circle the correct answer to each of these short answer questions (3 pts. each):

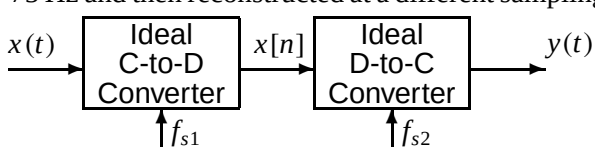
1. A signal $x(t)$ is defined by: $x(t) = \sum_{k=-10}^{10} k e^{j8\pi kt}$. The Nyquist Rate for sampling $x(t)$ is

   (a) 160 Hz
   (b) 80 Hz
   (c) 40 Hz
   (d) 160π Hz
   (e) 320π Hz

2. Determine the period (T) of the signal $x(t)$ defined by: $x(t) = \sum_{k=-10}^{10} k e^{j8\pi kt}$.

   (a) $T = 0.125$ sec.
   (b) $T = 4$ sec.
   (c) $T = 0.25$ sec.
   (d) $T = 80\pi$ sec.
   (e) $x(t)$ is *not* periodic

3. A signal $x(t) = 4\cos(100\pi t)$ is sampled at $f_{s1} = 75$ Hz and then reconstructed at a different sampling rate of $f_{s2} = 150$ Hz.

   The output of the ideal D-to-C converter is:

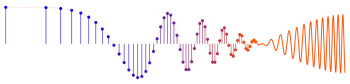
   (a) $y(t) = 4\cos(50\pi t)$
   (b) $y(t) = 4\cos(100\pi t)$
   (c) $y(t) = 4\cos(150\pi t)$
   (d) $y(t) = 4\cos(200\pi t)$

4. A rotating disk with one spot is spinning *clockwise* at the rate of 9 revolutions per second. If the disk is illuminated with a strobe light that flashes once every 0.1 seconds, determine the movement of the spot that you will see.

   (a) The spot appears to *stand still.*
   (b) The spot appears to rotate *counter-clockwise* at a rate of 9 revolutions per second.
   (c) The spot appears to rotate *clockwise* at a rate of 9 revolutions per second.
   (d) The spot appears to rotate *counter-clockwise* at a rate of 1 revolution per second.
   (e) The spot appears to rotate *clockwise* at a rate of 1 revolution per second.

McClellan, Schafer and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.
Prentice Hall, Upper Saddle River, NJ 07458.

SOLUTION



Circle the correct answer to each of these short answer questions:

1. A signal $x(t)$ is defined by: $x(t) = \sum_{k=-10}^{10} k e^{j8\pi kt}$. The Nyquist Rate for sampling $x(t)$ is

   (a) 160 Hz
   (b) 80 Hz
   (c) 40 Hz
   (d) 160π Hz
   (e) 320π Hz

   $f_{MAX} = \frac{1}{2\pi}(8\pi k_{MAX}) = \frac{1}{2\pi}(80\pi) = 40\text{Hz}$

   $f_s \geq 2f_{MAX} = 80\text{Hz}$

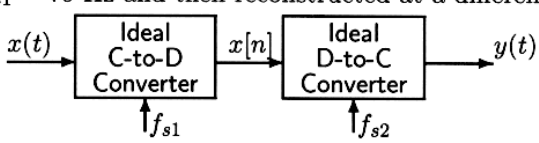
2. Determine the period (T) of the signal $x(t)$ defined by: $x(t) = \sum_{k=-10}^{10} k e^{j8\pi kt}$.

   (a) $T = 0.125$ sec.
   (b) $T = 4$ sec.
   (c) $T = 0.25$ sec.
   (d) $T = 80\pi$ sec.
   (e) $x(t)$ is *not* periodic

   $f_0 = 8\pi/2\pi = 4\text{Hz}$

   $T = 1/f_0 = 1/4$ sec

3. A signal $x(t) = 4\cos(100\pi t)$ is sampled at $f_{s1} = 75$ Hz and then reconstructed at a different sampling rate of $f_{s2} = 150$ Hz.

   The output of the ideal D-to-C converter is:

   (a) $y(t) = 4\cos(50\pi t)$
   (b) $y(t) = 4\cos(100\pi t)$
   (c) $y(t) = 4\cos(150\pi t)$
   (d) $y(t) = 4\cos(200\pi t)$

   $x[n] = 4\cos(100\pi n/75)$

   $\hat{\omega} = 100\pi/75 = 4\pi/3$

   Alias (Folding) $\Rightarrow \hat{\omega} = 4\pi/3 - 2\pi = -2\pi/3$

   $y(t) = 4\cos\left(-\frac{2\pi}{3}(150)t\right) = 4\cos(100\pi t)$

4. A rotating disk with one spot is spinning *clockwise* at the rate of 9 revolutions per second. If the disk is illuminated with a strobe light that flashes once every 0.1 seconds, determine the movement of the spot that you will see.

   $f_s = 10$ Hz
   spin at -9 Hz } Alias $-9 + 10 = 1$ Hz

   plus sign means CCW

   (a) The spot appears to *stand still.*
   (b) The spot appears to rotate *counter-clockwise* at a rate of 9 revolutions per second.
   (c) The spot appears to rotate *clockwise* at a rate of 9 revolutions per second.
   (d) The spot appears to rotate *counter-clockwise* at a rate of 1 revolution per second.
   (e) The spot appears to rotate *clockwise* at a rate of 1 revolution per second.

McClellan, Schafer, and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.
Prentice Hall, Upper Saddle River, NJ 07458.