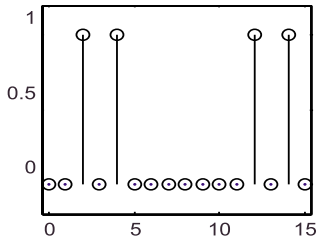
1. Given a signal, $x[n]$, of the form

$$x[n] = A_1 cos(\omega_1 n + \phi_1) + A_2 cos(\omega_2 n + \phi_2) + A_3 cos(\omega_3 n + \phi_3)$$

and it's 16-point DFT, X[k], which of the following *cannot* be true:

(a) The magnitude of $X[k]$ looks like



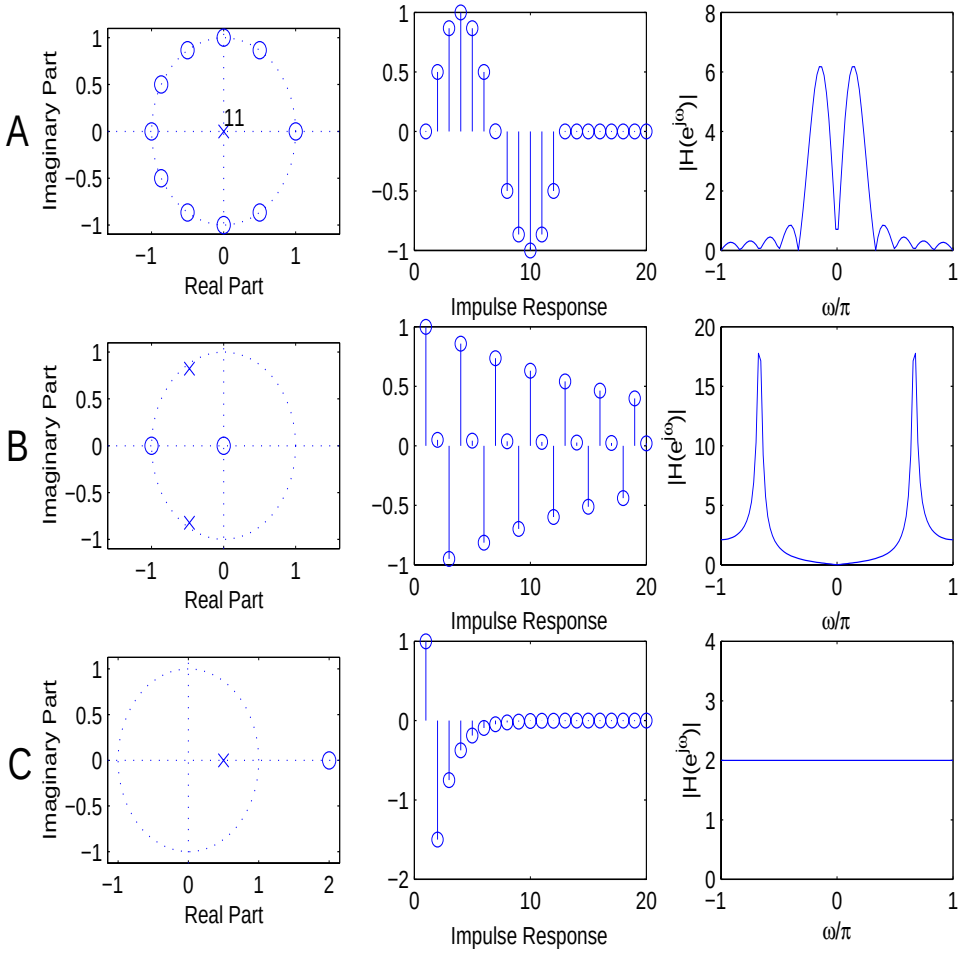
(b) $X[k] \neq 0$ for all k

(c) $X[0] = 1$

(d) More than one of the above

(e) None of the above

2. Which of the following sets of pole-zero plots, impulse responses, and frequency responses are inconsistent (that is, they cannot come from the same filter)?



(d) More than one of the above

(e) None of the above

3. Suppose that a radar system involving sliding correlation is implemented using a digital filter. A signal, $p[n]$, is transmitted, where

$$p[n] = \delta[n] + \delta[n-1] + \delta[n-2] - \delta[n-3] - \delta[n-4] - \delta[n-5]$$

The signal $x[n]$ is received, and the correlation signal, $y[n]$, is computed using the convolution formula

$$y[n] = \sum_{k=0}^{5} x[k]h[n-k]$$

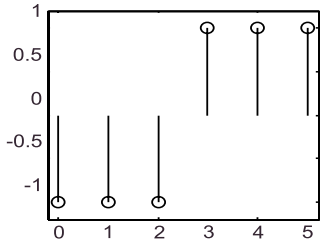
where $h[n]$ is the impulse response of the digital filter. (Note that $M = 5$.) Suppose that there is no noise, so $x[n]$ is simply a delayed version of $p[n]$; that is,

$$x[n] = p[n - n_0]$$

Which of the following is *not* true:

(a) $y[n]$ is always non-negative.

(b) The impulse response of the filter, $h[n]$, is given by



(c) The maximum value of $y[n]$ is 6.

(d) The maximum value of $y[n]$ occurs at $n = n_0$.

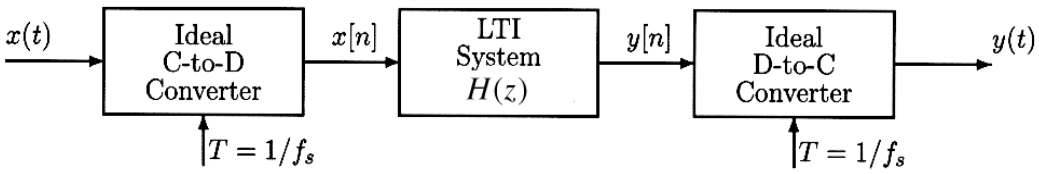
(e) More than one of the above.

4. The input to the C-to-D converter in the figure below is

$$x(t) = 4\cos(2000\pi t) + \cos(2\pi(800)t - pi/4) - 3\cos(2\pi(375)t)$$

The system function for the LTI system is

$$H(z) = 1 + z^{-4}$$



If $f_s = 1000$ samples per second, which of the following is true

(a) No aliasing occurs here.

(b) The magnitude of the frequency response of the system $H(z)$ at $\hat{\omega}$=0 is 0.

(c) The output signal has a sinusoidal component at 375 Hz.

(d) More than one of the above.

(e) None of the above

5. Suppose that a system is defined by

$$H(z) = (1 - z^{-1})(1 + z^{-1}) = 1 - z^{-2}$$

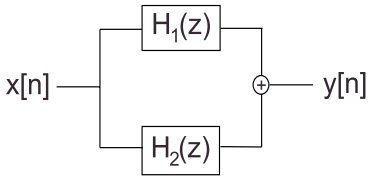
Given an input

$$x[n] = 5 - 4\delta[n] + 10\cos(0.5\pi n + \pi/3),$$

what is the output, $y[n]$?

(a) $y[n] = 4\delta[n] - 4\delta[n-2] + 10\cos(n\pi/2 + \pi/3)$
(b) $y[n] = -4\delta[n] + 4\delta[n-2] + 20\cos(n\pi/2 + \pi/3)$
(c) $y[n] = 5 + 4\delta[n] - 4\delta[n-2] + 20\cos(n\pi/2 + \pi/3)$
(d) $y[n] = -4\delta[n] + 4\delta[n-2] + 10\cos(n\pi/2 + \pi/3)$
(e) None of the above.

6. Suppose a system is given as



where

$$y[n] = 2x[n]$$

and

$$H_1(z) = \frac{1 + z^{-1} + z^{-2}}{1 + 2z^{-1} + 2z^{-2}}$$

What is $H_2(z)$?

(a) $H_2(z) = \frac{2+2z^{-1}+2z^{-2}}{1+2z^{-1}+2z^{-2}}$

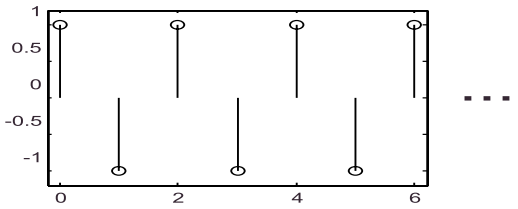
(b) $H_2(z) = \frac{1+3z^{-1}+3z^{-2}}{1+2z^{-1}+2z^{-2}}$

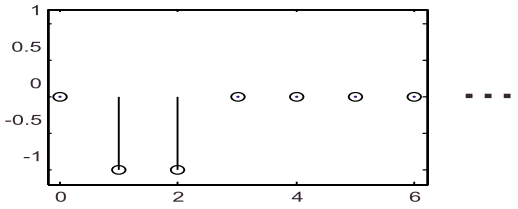
(c) $H_2(z) = \frac{2+4z^{-1}+4z^{-2}}{1+z^{-1}+z^{-2}}$

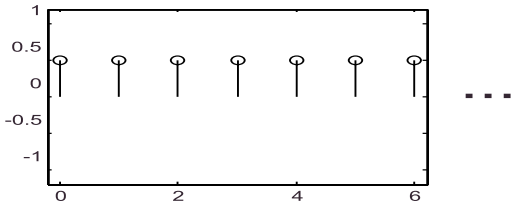
(d) $H_2(z) = \frac{2+6z^{-1}+10z^{-2}}{1+2z^{-1}+2z^{-2}}$

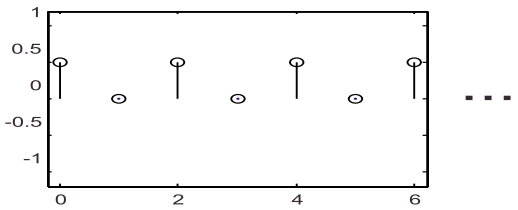
(e) None of the above.

7. A signal, $x(t) = \cos(2\pi 3000t + \pi/3)\cos(2\pi 1000t)$, is sampled at 4000 samples per second to yield $x[n] = x(nT_s)$. What is $x[n]$?

(a) 

(b) 

(c) 

(d) 

(e) None of the above

8. Suppose we have a continuous time signal, $x(t)$, that we sample with $f_s = 8192$ Hz to yield $x[n]$. Then, we take the 128-point DFT of $x[n]$ to yield $X[k]$. The result is given by

$$X[k] = \begin{cases} 1+j & k=3 \\ -\sqrt{3}+j & k=16 \\ 6 & k=64 \\ -\sqrt{3}-j & k=112 \\ 1-j & k=125 \\ 0 & \text{else} \end{cases}$$

Which of the following is a possible value for the original signal, $x(t)$?

(a) $2\sqrt{2}\cos(2\pi 192t + \pi/4) + 4\cos(2\pi 1024t + 5\pi/6) + 12\cos(2\pi 4096t + \pi/3)$

(b) $2\sqrt{2}\cos(2\pi 3t + \pi/4) + 4\cos(2\pi 16t + 5\pi/6) + 12\cos(2\pi 64t + \pi/3)$

(c) $2\sqrt{2}\cos(2\pi 192t - \pi/4) + 4\cos(2\pi 1024t + \pi/6) + 6\ cos(2\pi 4096t)$

(d) More than one of the above

(e) None of the above

9. Suppose that we have a signal $x(t)$, where

$$x(t) = 2.8\cos(2\pi 120t - \pi/3).$$

We sample $x(t)$ at $f_s = 80$ Hz and then compute it's 22-point DFT, $X[k]$. What is $X[k]$?

(a) $X[k] = 1.4\delta[k-10] + 1.4\delta[k-12]$

(b) $X[k] = 2.8\delta[k-10]$

(c) $X[k] = 1.4\delta[k-11]$

(d) $X[k] = 2.8\delta[k] + 2.8\delta[k-11]$

(e) $X[k] = 2.8\delta[k-11]$

10. Given the following input-output relationships, which is causal, linear, *and* time invariant?

    (a) $y[n] = ax[n] + b$

    (b) $y[n] = ax[n + b]$

    (c) $y[n] = 5x[an - b]$

    (d) $y[n] = a\,|x[n - b]|$

    (e) None of the above