1. Phase curves for all practical filters always have a negative slope. Why?

2. Describe a method whereby you could determine the frequency response plot for a filter when you have measurements of the impulse response for that filter.

3. A linear discrete system has a step response given by
s(nT) = {1, 1.5, 1.8, 1.8, 1.8, 1.8, . . .}.
Find the frequency response of this system at 0Hz and at fs/2.

4. Shown below is the phase curve for an FIR filter. What is the minimum number of zeros that the filter can have that are located on the unit circle. Justify you answer.
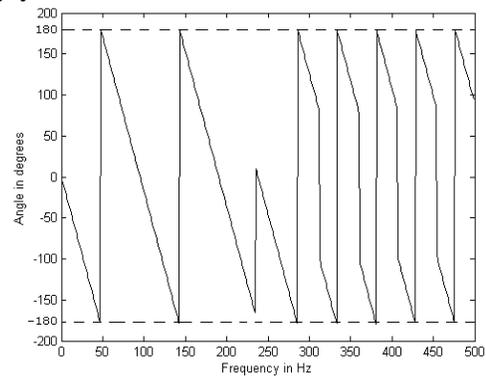
5. The impulse response for an ideal filter is used to create a windowed digital filter. The impulse response is given by:

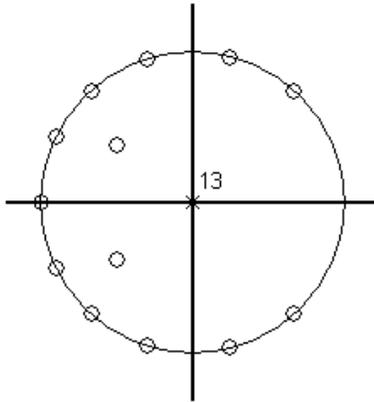$$h(n) = \sum_{n=-\infty}^{\infty} \frac{1}{2^{|n|}}$$

The final filter designed with this impulse response has a transfer function given by:

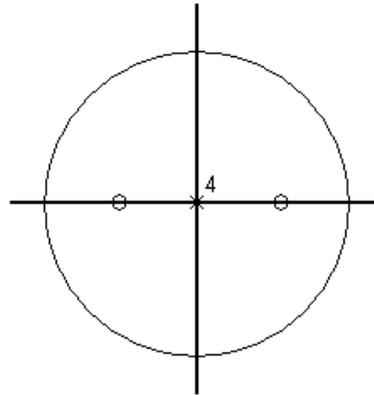$$H(z) = \frac{z^4 - 3z^3 + 2z^2 - 3z + 1}{z^4}$$

Find the window function, W(n) used to create this filter.

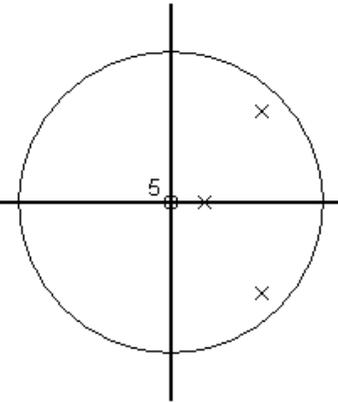6. Circle those terms below that apply to the filters in the pole/zero plots.

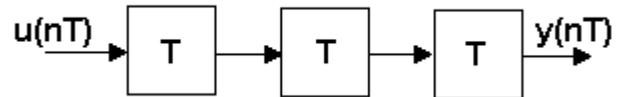a)   b)   c)

IIR/FIR   IIR/FIR   IIR/FIR
Stable/Unstable   Stable/Unstable   Stable/Unstable
Causal/Uncausal   Causal/Uncausal   Causal/Uncausal
LP HP BP BS   LP HP BP BS   LP HP BP BS
Lin/NonLin Phase   Lin/NonLin Phase   Lin/NonLin Phase

7. Answer the following questions for the system below.
   A) What is the impulse response?

   B) What is the transfer function in z?

   C) Does this system have linear phase or not. Justify your answer.

8. Circle the letters of ALL of the items below which are true.
   FIR filters
       A) always have linear phase
       B) never have feedback terms in the difference equation
       C) may have multiple poles at the origin
       D) may have poles at the $Z = -1$ point
       E) are always stable
       F) all of the above
       G) none of the above

9. Given the transfer function for an FIR filter below:

$$H(z) = 5\frac{(z+.5)(z+2)}{z^4}$$

    a) What is the phase shift at 0Hz? _____

    b) Rewrite the transfer function and add a single zero to the system to make the phase shift at
       0Hz = 90º.

    c) Rewrite the original transfer function and add a single zero to the system to make the
       phase shift at $f_s/2 = 90º$.

10. If a window function for an FIR filter has a very broad main lobe in the frequency domain, what characteristics would you expect if it is applied to a filter (in terms of ripple and transition band width).

11. On some FIR filters the phase curve has discontinuities in the stop band. Why?

12. The Parks-McClellan FIR design technique provides a method of designing an FIR filter that is optimal in the minimax sense. What does this mean?

13. What differences would you expect in three filters which were designed using a rectangular, a Hamming, and a Blackman window. Explain in terms of the magnitude plot for a lowpass filter.