X(z) denotes z-transform of x[n]  
\[ X(z) = \sum_{n=-\infty}^{\infty} x[n] z^{-n} \]

X(\omega) denotes the DTFT of x[n]  
\[ X(\omega) = \sum_{n=-\infty}^{\infty} x[n] e^{-j\omega n} \]

u[n] is the unit step, \( \delta[n] \) is the unit sample  
\( \omega \) denotes frequency in rad/sample

**Circle the Best Answer**

**Show All Work Even For Multiple Choice**

1. The system with z-transform \( H(z) = \frac{z^2 + 1}{(z+0.7)(z+0.9)} \) and ROC \(|z|<0.7\) is BIBO stable.
   a) True  
   b) False

2. The system \( H(z) = \frac{z^2 - 1}{(z+0.1)(z+1.2)} \) with ROC \( 0.1 < |z| < 1.2 \) has \( h[n] \) that is
   a) BIBO stable and right-sided  
   b) BIBO stable and two-sided  
   c) BIBO unstable and two-sided  
   d) none above

3. The z-transform of \( \delta[n-1] + 0.5 \delta[n-2] \) is
   a) \( z + 0.5 z^{-2}; \ |z|>0.25 \)  
   b) \( z^2 - 0.5 z; \ |z|>0 \)  
   c) \( z^{-1} + 0.5 z^{-2}; \ |z|>0 \)  
   d) none above

4. If a system has \( H(z) = \frac{10z^3 - 5z - 3}{30z^4 - 6z^3} \) and ROC \(|z|>0.2\) then, then \( h[1] = \)
   a) 0  
   b) -5/18  
   c) -1/6  
   d) 1/6  
   e) 2  
   f) none above

5. One of the zeroes of the z-transform \( H(z) = 1 - z^4 \) is at \( z = \)
   a) \( e^{j\pi/2} \)  
   b) \( e^{j\pi/4} \)  
   c) \( e^{-j\pi/8} \)  
   d) \( e^{j\pi/8} \)  
   e) none above
6. The z-transform of \( h[n] = u[n-1] - u[n-2] \) is \( H(z) = \)
   a) \( z^{-1} - z^{-2} ; \quad |z|>0 \) 
   b) \( \frac{z^2 - z^{-2}}{1 - z^{-1}} ; \quad 1<|z|<4 \)
   c) \( z^{-1} ; \quad |z|>0 \)
   d) none above

7. The z-transform of \( h[n] = (1/2)^{2n} u[n-1] \) is \( H(z) = \)
   a) \( \frac{4z}{z-1/4} ; |z|>1/4 \) 
   b) \( \frac{1}{4z-1} ; |z|>1/4 \) 
   c) \( \frac{z^{-1/2}}{z-1/2} ; |z|>1/2 \)
   d) none above

8. A system with z-transform \( H(z) = \frac{z^2-1}{z(z+0.01)(z-0.01)} ; \quad |z|>0.01 \) would be best described as
   a) lowpass 
   b) highpass 
   c) bandpass

9. If a filter has \( H(z) = \frac{z^2-0.9}{z^3-0.1} \) and ROC \( |z|>\sqrt{0.1} \), then the first 3 points of \( h[n] = \)
   a) \{1, 0, 0\} 
   b) \{1, 0, 1\} 
   c) \{0, 1, 0\} 
   d) \{1, 0, -0.8\} 
   e) none above

10. If a filter has \( H(z) = \frac{z^2-1/2}{z^2-1/4} \) ; ROC \( |z|>0.5 \), then the dc response of the filter is \( H(\omega)|_{\omega=0} = \)
    a) 1/3 
    b) 1/4 
    c) -1/4 
    d) 2/3 
    e) none above

11. The frequency of the signal \( h[n] = j^n \) in radians/sample is \( \omega = \)
    a) 0 
    b) 1 
    c) \( \pi/4 \) 
    d) \( \pi/2 \) 
    e) \( \pi \) 
    f) none above
12. If a filter has \( H(z) = \frac{z^2 + 4z + 4}{9z^2 + 6z + 1} \); \(|z|>1/3\), then response of the filter at \( \omega = \pi \) is
   a) -1/4  
   b) 1/2  
   c) 1/4  
   d) -1/2  
   e) none above

13. If \( H(z) = \frac{1}{z} + \frac{z}{2z+1} \); \(|z|>1\), then the zeroes of \( H(z) \) are at \( z = \)
   a) 1, -1  
   b) -1/4, -1  
   c) 1/4, 0  
   d) -1, -1  
   e) none above

14. If \( H(z) = \frac{2z}{z+1/2} + \frac{8z}{4z-1} \); \(|z|>1/2\), then \( h[n]= \)
   a) \((1/8)^n u[n]\)  
   b) \((4(1/2)^n u[n] + (4(1/4)^n u[n] \)
   c) \(2(-1/2)^n u[n] + (1/4)^n u[n] \)
   d) \(2(-1/2)^n u[n] + 2(1/4)^n u[n] \)
   e) none above

15. If a filter has impulse response \( h[n] = (1/3)^{n-1} u[n-1] \), the dc response of the filter is \( H(\omega)|_{\omega=0} = \)
   a) 0  
   b) \(0.5e^{-j2\omega}\)  
   c) 1.5  
   d) 2  
   e) none above

16. If a filter has impulse response \( h[n] = u[n-1] - u[n-5] \), the filter response at frequency \( \omega = \pi/2 \) is \( H(\omega)|_{\omega=\pi/2} = \)
   a) 0  
   b) \(e^{-j4}\)  
   c) \(j4\)  
   d) \(4e^{-j\pi/2}\)  
   e) none above

17. A filter with \( H(z) = \frac{z^2 + 4z + 1}{z^2 + 4} \); with ROC \(|z|<2\) is causal.
   a) True  
   b) False

18. If \( H(z) = \frac{2z^2 - 2z}{z^2 + 1/9} \), then the poles of \( H(z) \) are at \( z = \)
   a) 1/3, -1/3  
   b) j3, -j3  
   c) 1/3, j/3  
   d) j/3, -j/3  
   e) none above
For the following questions:

\[ H(z) = \frac{z^2 - 1/16}{z^2 + 1/4} \]

19. Sketch the poles and zeroes in the figure above.

20. Assuming a causal system, sketch the region convergence in the figure above.

**Show your work for the 2 above problems in the space below.**