ELEC 6026: DIGITAL SIGNAL PROCESSING

I. Discrete-time signals and Systems

1. Which of the following is less prone to system noise due to transmission and storage?

a.) Analogue signal   b.) Digital signal

2. Which of the following system(s) observe the principle of superposition?

a.) $y[n]=(x[n])^2$ b.) $y[n]=\frac{1}{M_1+M_2+1}\sum_{k=-M_1}^{M_2} x[n-k]$ c.) $y[n]=x[n-n_d]$

3. Which of the following system is NOT a time-invariant system?

a.) $y[n]=x[Mn]$ b.) $y[n]=x[n-n_d]$ c.) $y[n]=(x[n])^2$

4. Which of the following system is a non-causal system?

a.) $y[n]=x[n+1]-x[n]$ b.) $y[n]=x[Mn]$ c.) $y[n]=x[n-n_d]$

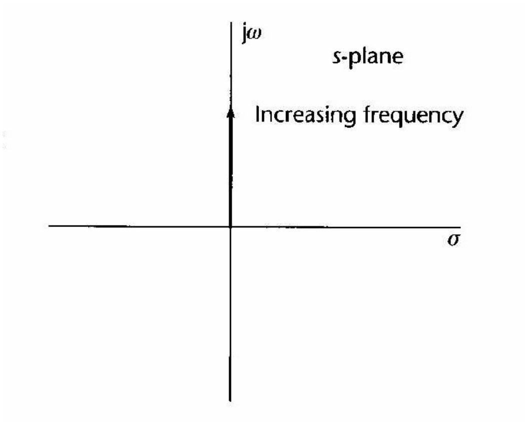
5. Which of the following system(s) have an finite-duration impulse response?

a.) $H(z)=\frac{2-2.4z^{-1}-0.4z^{-2}}{(1-0.3z^{-1}-0.4z^{-2})}$ b.) $H(z)=2-2.4z^{-1}-0.4z^{-2}$ c.) $H(z)=\frac{1}{1-0.3z^{-1}}$

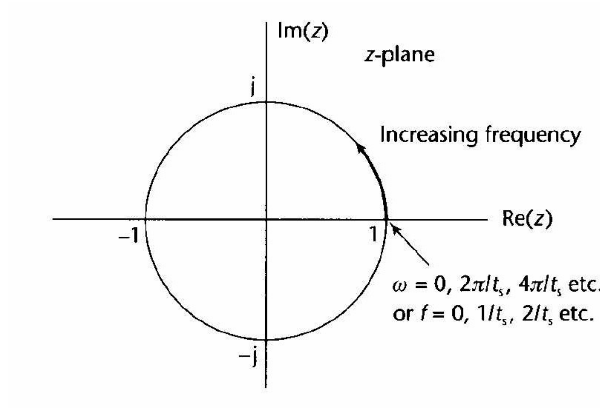
6. Which of the following system(s) have an infinite-duration impulse response?

a.) $y[n]=a\cdot y[n-1]+x[n]$ b.) $y[n]=x[n+1]-x[n]$ c.) $y[n]=(x[n])^2$

II. The z-transform



s-plane



Z-plane

1.) Given $z \equiv e^{st_s}$ **and** $s = \sigma + j\Omega$ **, which of the following is true?**

A) Right half plane (RHP) of the s-plane is mapped to the outside of the unit circle in z-plane.

B) Right half plane (RHP) of the s-plane is mapped to the inside of the unit circle in z-plane.

C) Left half plane (RHP) of the s-plane is mapped to the outside of the unit circle in z-plane.

D) Left half plane (RHP) of the s-plane is mapped to the inside of the unit circle in z-plane.

a.) (A) is true. b.) (A) and (C) are true. c.) (A) and (D) are true d.) (B) and (D) are true

2.) Following Q1, if the system is causal and all of the poles lies inside the unit circle of the z-plane, which of the following is TRUE?

a.) The system is stable. b.) The system is instable.

3.) Following Q2, if the system is now non-causal with the same poles, is the system stable?

a.) The system is stable. b.) The system is instable.

III.

Consider a causal linear time-invariant (LTI) system with the following transfer function relating its input $x(n)$ and output $y(n)$:

$$H(z) = \frac{2 - 2.4z^{-1} - 0.04z^{-2}}{(1 - 0.3z^{-1} - 0.04z^{-2})}.$$

i) Determine the linear constant coefficient difference equation for implementing the output $y(n)$.

ii) Determine the poles of $H(z)$.

iii) What is the region of convergence (ROC) of the z-transform if the system is causal.

iv) Determine the impulse response, $h(n)$, (i.e. the response of the system to the unit impulse sequence $\delta(n)$) of this system, given that the system is causal. Is the system stable?

v) Determine the z-transform of $x(n) = e^{j(n\omega_0)}$.

vi) Determine the output $y(n)$ of the system to $x(n) = e^{j(n\omega_0)}u(n)$.

vii) If the above system is now non-causal and has the same transfer function $H(z)$, is it still stable? Explain.

viii) If the ROC is now changed to $|p_1| < |z| < |p_2|$, where p_1 and p_2 are the two poles of $H(z)$. Determine the impulse response of $H(z)$.