University of Nebraska-Lincoln
Digital Signal Processing: Quiz 4

September 26, 2025

Name: _____ **Total Points: 10**

Given: A linear time-invariant (LTI) system has the impulse response:

$$h[n] = (0.8)^n u[n] - (0.5)^n u[n-3]$$

where $u[n]$ is the unit step function.

1. **(5 points)** Determine if this system is **stable**. Show your work and justify your answer using the appropriate stability criterion for discrete-time LTI systems. **Solution:**

   For a discrete-time LTI system to be stable, the impulse response must be absolutely summable:

   $$\sum_{n=-\infty}^{\infty} |h[n]| < \infty$$

   For $n \geq 3$:

   $$|h[n]| = |(0.8)^n - (0.5)^n| \leq (0.8)^n + (0.5)^n$$

   For $0 \leq n < 3$:

   $$|h[n]| = (0.8)^n$$

   Since both $(0.8)^n$ and $(0.5)^n$ are geometrically convergent series, the system is **stable**.

2. **(5 points)** Determine if this system is **causal**. Show your work and justify your answer using the appropriate causality criterion for discrete-time LTI systems. **Solution:**

   For a discrete-time LTI system to be causal, the impulse response must satisfy:

   $$h[n] = 0 \text{ for } n < 0$$

   Analyzing $h[n] = (0.8)^n u[n] - (0.5)^n u[n-3]$:
   For $n < 0$: Both $u[n] = 0$ and $u[n-3] = 0$, so $h[n] = 0$.
   Since $h[n] = 0$ for all $n < 0$, the system is **causal**.