

ECE-486 Spring 2008, Test 1
Feb 27, 2008

Name : _____

1. For each of the following systems, indicate whether the system is linear, causal, time-invariant, and BIBO stable. In each case, $x(n)$ and $y(n)$ denote the system input and output respectively. (No partial credit. Indicate “Y” for Yes, “N” for No, and “X” for “can’t be determined from the given information.”)

(a) $y(n) = \cos(\sqrt{|n|})x(n)$

i. Linear? _____ ii. Causal? _____ iii. Time-Invariant? _____ iv. Stable? _____

(b) The response of the system to input $x(n) = \delta(n - 1)$ is $y(n) = (0.5)^n u(n)$.

i. Linear? _____ ii. Causal? _____ iii. Time-Invariant? _____ iv. Stable? _____

(c) $y(n) = \beta + \sum_{\ell=0}^{\infty} x(n - \ell)$.

i. Linear? _____ ii. Causal? _____ iii. Time-Invariant? _____ iv. Stable? _____

2. The sequence $x(n)$ is known to have finite energy. Specify the region of convergence, and evaluate the inverse z -transform of the following:

$$X(z) = z^2 + \frac{5}{z(z - 0.5)} + \frac{z^2 + 1}{z + 3}$$

R.O.C.: _____

3. A Linear time-invariant system with input $x(n)$ and output $y(n)$ has impulse response

$$h(n) = \{\dots, 0, 0, 1, 2, \underset{\uparrow}{4}, 2, 1, 0, 0, 0, \dots\}$$

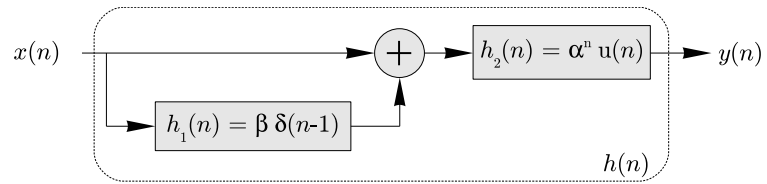
(a) Is this a stable system? (justify)

(b) Find $y(3)$ for input

$$x(n) = \{\dots, 0, 0, 2, -1, \underset{\uparrow}{6}, 2, 1, 3, 4, 7, 1, -1, -6, 5, 0, 0, 0, \dots\}$$

(c) Evaluate $H(f)$. Simplify your result to show that $H(f)$ is real. Calculate the filter gain for discrete-time frequencies $f = 0$, $f = 0.25$, and $f = 0.5$.

4. Consider the system illustrated below



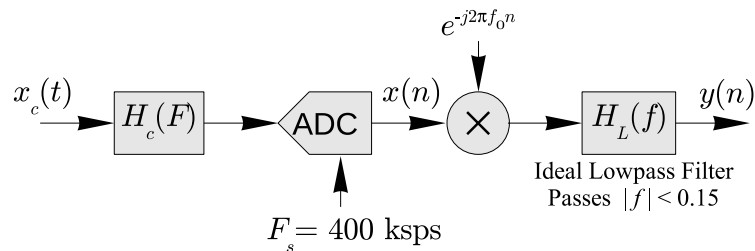
- Find the impulse response $h(n)$ for the entire system.
- Find the transfer function $H(z)$ for the entire system. Specify the ROC for your result.
- Is this system causal?
- Is this system stable?

5. A causal system is described by the difference equation

$$y(n) - \frac{3}{2}y(n-1) + \frac{1}{2}y(n-2) = 2x(n) - x(n-1)$$

- (a) Evaluate the impulse response for the system.
- (b) Is the system stable? (Justify)
- (c) Find the system output for $x(n) = \delta(n-3)$, $y(-1) = 2$, $y(-2) = 1$.
- (d) Draw the direct-form II implementation of the system.

6. LORAN Navigation systems are based on an amplitude-modulated transmitted pulse sequence which occupies the 80 to 120 kHz band of frequencies. An digital LORAN receiver is to be designed using a 400 ksp/s analog-to-digital converter. A block diagram of the proposed receiver is illustrated below.



- Identify the (continuous-time) frequencies which must be eliminated by the filter $H_c(F)$ to avoid distortion of the LORAN signal. (Include Units)
- Identify the discrete-time frequencies associated with the LORAN signal for the sequence $x(n)$.
- The multiplier and low-pass filter are used to translate the LORAN spectrum to $f = 0$ and filter out undesired signal outside of the LORAN band of frequencies. Specify the appropriate mixer frequency f_0 . Explicitly list the mixer input sequence $e^{-j2\pi f_0 n}$ for $n = 0, 1, \dots, 8$.
- What is the minimum sample rate which is required to represent the resulting output sequence $y(n)$?