

Assignment - 3

Properties of Linear Time-Invariant Systems

February 7, 2018

Task 1

Let

$$y[n] - \frac{1}{4}y[n-1] - \frac{1}{8}y[n-2] = 3x[n]$$

with $y[-1] = y[-2] = c$, $c \in \{0.5, 0.3, 0\}$ be the difference equation describing a system.

Questions

1. Is this a linear system? Why or why not? Choose a suitable input and show the output using MATLAB to justify your answer. For what values of c the system is linear?
2. Is this a causal system? Why or why not? Choose a suitable input and show the output using MATLAB to justify your answer. For what values of c the system is causal?
3. Plot the impulse response of the system for $c = 0.5, c = 0.3, c = 0$? For what values of c you can find out whether the system is causal using the impulse response and why?
4. Find out the answers of the questions above on paper. Do your answers match with the one you found out with MATLAB?

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Task 2

Consider the following systems:

1. $y[n] = \cos(\pi n)x[n]$.
2. $y[n] = x[n^2]$.

Questions

1. Prove on paper whether these systems are linear, stable, causal and time-invariant?
2. Verify your answers using MATLAB. If the system is unstable, you need to verify by giving it the bounded input that makes the output unbounded.

Task 3

Plot the Fourier transform of $x[n] = \left(\frac{1}{6}\right)^n u[n]$.

Questions

1. Is the magnitude response even or odd? Justify your answer.
2. Is the phase response even or odd? Justify your answer.
3. Is the real response even or odd? Justify your answer.
4. Is the imaginary response even or odd? Justify your answer.
5. Is the Fourier transform conjugate symmetric? Why or why not?