

In-Class Quiz #2

ECE 565, Spring 2009

(24 February 2009. Closed books, closed notes, no electronic devices)

Problem 1 (8 pts. total): *Check the correct answers and leave the wrong answers unchecked.*

A system whose properties do not change with time and whose output value is independent of future input values is

- linear;
- memoryless;
- causal;
- time-invariant;
- LTI;
- causal and linear;
- causal and time-invariant;
- causal and LTI.

Problem 2 (4 pts. total): *Check the correct answers and leave the wrong answers unchecked.*

Consider the system with the input-output relationship

$$y[n] = \frac{1}{5} \sum_{k=n-2}^{n+2} x[k].$$

The system is

- causal;
- memoryless;
- linear;
- time-invariant.

Problem 3 (6 pts. total): *Impulse response, step response, frequency response.*

For the system introduced in Problem 2, find

- (a, 2 pts.) the impulse response (simplify the result as far as possible);
- (b, 2 pts.) the step response (simplify the result as far as possible);
- (c, 2 pts.) the frequency response (simplify the result as far as possible).

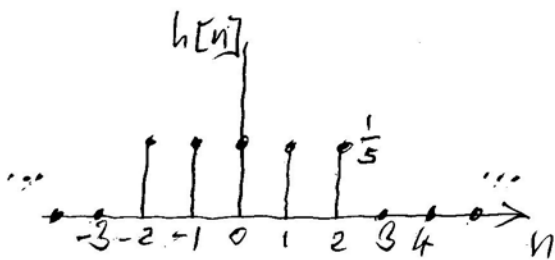
Problem 3

System input-output relationship:

$$y[n] = \frac{1}{5} \sum_{k=n-2}^{n+2} x[k]$$

(a) To find impulse response, set $x[k] = \delta[k]$ and find $y[n] \equiv h[n]$:

$$h[n] = \frac{1}{5} \sum_{k=n-2}^{n+2} \delta[k] = \frac{1}{5} [\delta[n-2] + \delta[n-1] + \delta[n] + \delta[n+1] + \delta[n+2]]$$

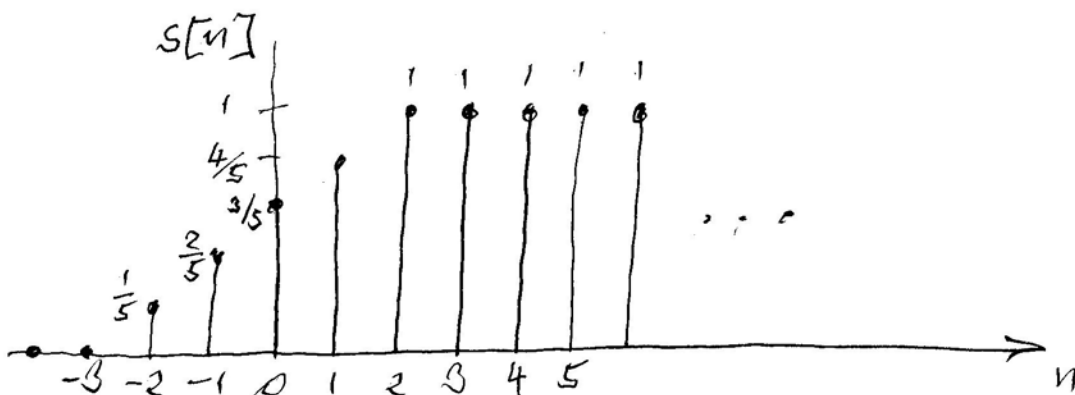


$$= \begin{cases} \frac{1}{5}, & -2 \leq n \leq 2 \\ 0, & \text{otherwise} \end{cases}$$

(b) Step response: Let $x[k] = u[k]$

$$\Rightarrow s[n] = \frac{1}{5} \sum_{k=n-2}^{n+2} u[k] =$$

$$= \frac{1}{5} [u[n-2] + u[n-1] + u[n] + u[n+1] + u[n+2]]$$



Problem 3 cont'd

(c) Frequency response:

$$\begin{aligned} H(e^{j\omega}) &= \mathcal{DFT}\{h[n]\} = \sum_{n=-\infty}^{\infty} h[n] e^{-j\omega n} \\ &= \frac{1}{5} \sum_{n=-\infty}^{\infty} (\delta[n-2] + \delta[n-1] + \delta[n] + \delta[n+1] + \delta[n+2]) e^{-j\omega n} \\ &= \frac{1}{5} (e^{-j2\omega} + e^{-j\omega} + e^{-0} + e^{+j\omega} + e^{+j2\omega}) \\ &= \frac{1}{5} (2 \cos(2\omega) + 2 \cos \omega + 1) \\ &= 1 + \frac{2}{5} \cos \omega + \frac{2}{5} \cos(2\omega) \end{aligned}$$