Name Answers

EE-3220 – Dr. Durant – Quiz 2
Winter 2016-'17, Week 2

1. (4 points) Indicate whether each of the following systems is linear, time-invariant, and causal. You ***do not*** need to show your work for this problem.

	$y_1(n) = x(n-3)$	$y_2(n) = x^2(n+2)$	$y_3(n) = nx(n-1)+2$
Linear?	+	− (due to square)	− (due to +2)
Time-invariant?	+	+	− (due to n multiplier)
Causal?	+	− (due to n+2)	+

2. (3 points) Calculate the non-0 portion of the sequence resulting from $x(n) = n^2 \cos(n\frac{\pi}{4})(u(n+2)-u(n-2))$. Recall that *u(n)* is the unit step that becomes 1 when the argument reaches 0. Clearly indicate the *n=0* position in your sequence.

3. (1 point) Express your sequence above as a weighted sum of shifted unit samples or deltas ($\delta(n-k)$).

4. (2 points) Given that a linear, time-invariant (LTI) system has impulse response h(n), explain what the term h(3) specifies. That is, what does it say about the relationship between the system input and system output?

** for $\omega = \frac{\pi}{2}$

(2) $u(n+2) - u(n-2) \Rightarrow$ non-zero values can only be on $-2 \le n \le 1$

OVER for $\omega = \pm\frac{\pi}{4}$

$n = 0 \rightarrow n^2 = 0 \rightarrow x(0) = 0$

$n = \pm 1 \rightarrow x(n) = \cos\left(\pm\frac{\pi}{4}\right) = 0 \rightarrow x(\pm 1) = 0$

$n = -2 \rightarrow x(n) = \cos\left(-2\cdot\frac{\pi}{4}\right) = \cos\left(\frac{-\pi}{2}\right) = -1 \rightarrow x(-2) = -1$

$x = [-1 \;\; 0 \;\; 0]$ (n=0 point)

This is not the problem on the quiz. Here, omega=pi/2. See quiz solution on next page.

(3) $x(n) = -\delta(n+2)$

(4) $h(3)$ gives the gain at output 3 samples after an input occurs. For example, if $4\delta(n-2)$ is added to the input, $12\delta(n-5)$ will be added to the output. ($4 \to x(k)$, $2 \to k$; $h(3)\times(2)$; $\delta(n-(k+3))$)

$k = 2$ = delay of input from time origin $n=0$

$+3$ = delay of output from input

5 = delay of output from $n=0$

(2) $x(n) = n^2 \cos\left(n\frac{\pi}{4}\right)\left(u(n+2) - u(n-2)\right)$

$-2 \le n \le 1$ for non-zero x

n	n^2	$n\frac{\pi}{4}$	$\cos\left(n\frac{\pi}{4}\right)$
-2	4	$-\frac{\pi}{2}$	0
-1	1	$-\pi/4$	$1/\sqrt{2}$
0	0	0	1
1	1	$\pi/4$	$1/\sqrt{2}$

$\therefore x(n) \neq 0$ only for $n = \pm 1$

$x = \left[\frac{1}{\sqrt{2}} \quad \underline{0} \quad \frac{1}{\sqrt{2}}\right]$

(3) $x(n) = \frac{1}{\sqrt{2}}\delta(n+1) + \frac{1}{\sqrt{2}}\delta(n-1) = \frac{1}{\sqrt{2}}\left(\delta(n+1) + \delta(n-1)\right)$