EE-3220-11 – Dr. Durant – Quiz 2
Winter 2014-'15, Week 2

1. (3 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.

<table>
<thead>
<tr>
<th>Linear?</th>
<th>Time-invariant?</th>
<th>Causal?</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>-</td>
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<tr>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

2. (2 points) Write the non-0 portion of the sequence resulting from \( x(n) = -\left(\frac{1}{3}\right)^n (u(n+2) - u(n-2)) \). 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. (2 points) Express your sequence above as a weighted sum of shifted unit samples or deltas \((\delta(n))\).

4. (1 point) Let the impulse response of a system be \( h(n) = [h(-1) \ h(0)] = [2 \ 3] \). Explain why this system is not causal.

5. (2 points) Calculate the convolution \( y(n) = x(n) * h(n) \). Show your work (intermediate products; you are not required to show the formula for the convolution sum). Indicate where \( n=0 \).

\[
\begin{align*}
\text{(2)} & \quad \begin{bmatrix} 1 & 1 & 1 \\ \uparrow & \downarrow & \uparrow \end{bmatrix} = \begin{bmatrix} -4 & -2 & -1 & -\frac{2}{3} \end{bmatrix} \\
\text{(3)} & \quad \delta(n) = -4\delta(n+2) - 2\delta(n+1) - \delta(n) - \frac{1}{2}\delta(n-1) \\
\text{(4)} & \quad h(-1) \neq 0 \Rightarrow \text{system output anticipates input before input} \\
\text{(5)} & \quad \begin{bmatrix} -3 & -2 & -1 & 0 & 1 \\ -2 & -4 & -1 & -2 & 0 \end{bmatrix} \begin{bmatrix} -8 & -12 & -6 \\ -4 & -4 & -2 & -3 \\ -1 & -1 \frac{2}{3} \\ -8 & -16 \end{bmatrix} \Rightarrow \begin{bmatrix} -8 & -16 & -8 & -4 \frac{3}{2} \end{bmatrix} \uparrow
\end{align*}
\]
EE-3220-21 – Dr. Durant – Quiz 2
Winter 2014–15, Week 2

1. (3 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.

<table>
<thead>
<tr>
<th>Linear?</th>
<th>y₁(n) = x(n-3)</th>
<th>y₂(n) = x(n)+2</th>
<th>y₃(n) = x²(n-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Time-invariant?</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Causal?</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

2. (2 points) Write the non-0 portion of the sequence resulting from x(n) = \((-\frac{1}{2})^n\) u(n+1) - u(n-3)). 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. (2 points) Express your sequence above as a weighted sum of shifted unit samples or deltas (δ(t)).

4. (1 point) Let the impulse response of a system be h(n) = [h(0) h(1)] = [5 -3]. Explain why this system is causal.

5. (2 points) Calculate the convolution y(n) = x(n)*h(n). Show your work (intermediate products; you are not required to show the formula for the convolution sum). Indicate where n=0.

\[
\begin{align*}
2) & \quad \left(\frac{-1}{2}\right)^n \begin{bmatrix} 1 & 1 \end{bmatrix} = \begin{bmatrix} -2 & \frac{1}{2} \end{bmatrix} \\
3) & \quad x(n) = -2δ(n+1) + 5δ(n) - \frac{5}{2}δ(n-1) + \frac{3}{2}δ(n-2) \\
4) & \quad h(k) = 0 \text{ if } k < 0 \Rightarrow \text{ the output does not arrive before the input}
\end{align*}
\]

\[
\begin{align*}
5) & \quad k \times x(k) = \begin{bmatrix} -1 & 0 & 1 & 2 & 3 \\
-1 & -2 & -10 & 6 & -3 \\
0 & 1 & 5 & -\frac{3}{2} & \frac{3}{2} \\
1 & 1 & 1 & \frac{3}{2} & \frac{-3}{2} \\
2 & 1 & -\frac{3}{2} & \frac{3}{2} & \frac{3}{4} \\
\end{bmatrix} \\
& \quad \uparrow
\end{align*}
\]