ECE161A
Discrete Time Signal Processing

October 8, 2007
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Problem Set #3
Due: Thursday, Oct 18, 2006

1. Consider discrete-time LTI systems with input x[n] and output y[n] related by parts a-c. For each of the systems find the impulse response if possible. In addition for each part, determine if the system is causal and stable.
   a) $y[n] = \sum_{k=-\infty}^{n} 3^{n-k} x[k+1]$
   b) $\frac{1}{M_1+3} \sum_{k=-M_1}^{2} x[n-k]$ (moving average)
   c) $y[n] = 1.1y[n-1] + x[n], n \geq 0$ (i.e. the system is initially at rest)

2. Determine the causality and the stability for the systems with the following impulse responses:
   a) $h[n] = \sqrt{n} e^{n} u[2n]$
   b) $e^{-\sqrt{n}} \cos[n] u[n+2]$

3. Consider a moving average filter:

$$y[k] = 3x[k] - 5x[k-1] - 2x[k-3]$$

   - Find the impulse response of this filter
   - Consider a signal x with a finite length 2, i.e. $x[n]$ is non zero only if $0 \leq n \leq 1$. Can you write the convolution equation as a matrix equation?
   - Use this matrix equation to define *deconvolution* mathematically.
   - Use deconvolution to determine what x (as described above) generates the sequence $1 \quad 1 \quad 1 \quad 1 \quad 1$ at the output, i.e. $y[0] = 1$, $y[1] = 1, \ldots y[4] = 1$.

4. Prove that the serial connection of two passive LTI systems is also passive.

5. Problem 2.87 of the textbook