EE 403 DIGITAL SIGNAL PROCESSING
TUTORIAL SHEET 1

1. A discrete-time system can be (a) memoryless or can have memory,
(b) Linear or nonlinear ,
(c) Time invariant or time varying,
(d) Causal or noncausal ,
(e) Stable or unstable .
Examine the following syatems with respect to the properties above.
(a) $y(n) = \cos[x(n)]$,
(b) $y(n) = \sum_{k=-\infty}^{n+1} x(k)$,
(c) $y(n) = x(n)\cos\omega_0 n$
(d) $y(n) = Round[x(n)]$, where $Round[x(n)]$ denotes the integer part of $x(n)$ obtained by rounding.
(e) $y(n) = x(n)$ if $x(n) \geq 0$
0 if $x(n) < 0$
(f) The ideal sampling syatem with input $x_a(t)$ and output $x(n) = x_a(nT)$, $-\infty < n < \infty$.

2. The following input-output pairs have been observed during the operation of a linear system.
$x_1(n) = \{-1, 2.1\} \leftrightarrow y_1(n) = \{1, 2, -1, 0, 1\}$
$x_2(n) = \{1, -1, -1\} \leftrightarrow y_2(n) = \{-1, 1, 0, 2\}$
$x_3(n) = \{0, 1, 1\} \leftrightarrow y_3(n) = \{1, 2, 1\}$
Can you draw any conclusions about the time invariance of this system?

3. Compute the convolution $y(n) = x(n) * h(n)$ of the following signals.
(a) $x(n) = \{1, 2, -1\}$, $h(n) = x(n)$
(b) $x(n) = (\frac{1}{2})^n u(n)$, $h(n) = (\frac{1}{4})^n u(n)$
(c) $x(n) = u(n) - u(n-5)$, $h(n) = u(n-2) - u(n-3) + u(n-4)$

4. Determine the unit step response of the system described by the difference equation $y(n) = 3y(n-1) + 4y(n-2) + x(n)$. Also find the output when the input $x(n) = 2^n u(n)$.

5. Consider the interconnection of LTI systems as shown in Figure.
(a) Express the overall impulse response in terms of $h_1(n), h_2(n), h_3(n) \& h_4(n)$.
(b) Determine $h(n)$ when $h_1(n) = \{\frac{1}{2}, \frac{1}{4}, \frac{1}{2}\}$,$h_2(n) = h_3(n) = (n+1)u(n)$, $h_4(n) = \delta(n-2)$.
(c) Determine the response of the system in part (b) if $x(n) = \delta(n+2) + 3\delta(n-1) - 4\delta(n-3)$.