HW #3

DUE: Wednesday, October 22, 2008 (by 5PM in the HW box)
NOTE: You are not allowed to use MATLAB to solve the problems on convolution. You may use the software only to verify your results. Show your calculations in the assignment you turn in.

Q1. Determine, for each of the following systems defined by the input/output relations, whether the system is (i) linear, and (ii) shift invariant. ("$[n]$" and "$[m,n]$" represent a 1-d and 2-d discrete time variables, respectively.) In the following, $y[n]$ denotes the output of a system for input $x[n]$.
(a). $y[n] = x[n/L]$, where L is a constant.
(b). $y[n] = n^3 x[n]$
(c). $y[m,n] = x[a,b]$, where a, b are constants.
(d). $y[m,n] = x[ln(n), ln(m)]$ where $ln(\cdot)$ represents natural logarithm (i.e., *log* to base 'e').

Q2. Compute $y[n] = x_1[n] * x_2[n]$ for each of the following cases, where $x_1[n]$ and $x_2[n]$ represent the two input sequences and '*' indicates linear discrete convolution. The boxed value represents the origin.
(a). $x_1[n] = \begin{bmatrix} 1 & 2 & \boxed{3} & 4 & 5 \end{bmatrix}$, $x_2[n] = \begin{bmatrix} 1 & 1 & \boxed{1} & 1 \end{bmatrix}$
(b). $x_1[n] = \begin{bmatrix} 35 & 47 & \boxed{5} & 4 & 9 \end{bmatrix}$, $x_2[n] = \begin{bmatrix} 0 & 0 & \boxed{0} & 1 \end{bmatrix}$

Q3. Compute $y[m,n] = x[m,n] * u[m,n]$ where $u[m,n]$ represents the 2-d unit step function and $x[m,n]$ is defined as follows:

$$x[m,n] = \begin{bmatrix} 0 & 1 & 0 \\ 1 & \boxed{-4} & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

Q4. Compute $y[m,n] = x[m,n] * h[m,n]$ where $x[m,n]$ and $h[m,n]$ are defined as follows:

$$x[m,n] = \begin{bmatrix} \boxed{-1} & 1 \\ 1 & 0 \end{bmatrix}, \quad h[m,n] = \begin{bmatrix} 3 & 3 & 2 & 3 \\ 1 & \boxed{2} & 1 & 2 \\ 2 & 1 & 2 & 1 \\ 1 & 0 & 2 & 1 \end{bmatrix}$$