Assignment 1 (Due in one week):

**Problem 1:**
In each of the following systems find the PSF and determine whether or not the system is linear, space invariant, FIR or IIR. Comment on the BIBO stability of these systems.

(a) \( y(m,n) = 3x(m,n) + 9 \)

(b) \( y(m,n) = m^2 n^2 x(m,n) \)

(c) \( y(m,n) = \sum_{k=-\infty}^{m} \sum_{l=-\infty}^{n} x(k,l) \)

(d) \( y(m,n) = \exp\{- |x(m,n)|\} \)

**Problem 2:**
(a) Determine the convolution of \( x(m,n) \) of the Example 1 in class with each of the following arrays, where the boxed element denotes the \((0,0)\) location.

(b) Verify your answers in each case via the area conservation property.

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**Problem 3:**
Convolve the 2-D sequence \( x(m,n) = a^m b^n u(m,n) \) with the following sequence.

\( y(m,n) = \sum_{r=-\infty}^{n} \delta(m-rN, n-rN) \)

**Problem 4:**
(a) All that is known about the sequence \( x(m,n) \) and \( h(m,n) \) is the fact that each has a region of support (ROS) that is restricted to the 1st quadrant i.e.

\[
\begin{align*}
x(m,n) &= 0 & \text{if } m < 0 \text{ or } n < 0 \\
h(m,n) &= 0 & \text{if } m < 0 \text{ or } n < 0
\end{align*}
\]

Show that the ROS of their convolution is also limited to that quadrant.

(b) Repeat part (a) assuming this time that \( x \) and \( h \) are each confined to the 3rd quadrant.

(c) Suppose now that \( x \) and \( h \) are each one-quadrant sequences but that each has ROS on a different quadrant. What statement, if any, can be made about the ROS of their convolution.

**Problem 5:**
Consider two 2-D sequences that are separable i.e. \( x(m,n) = a(m)b(n) \) and \( h(m,n) = c(m)d(n) \)

(a) Show that their convolution is a separable signal.

(b) Express that convolution in terms of \( a, b, c \) and \( d \).