3.1 (1A) Given: $\mathbf{x_1[n] = \delta[n] - 2\delta[n-1]}$

$$\mathbf{x_2[n] = 2\delta[n] + \delta[n-1] - \delta[n-2]}$$

3.1.1 Compute the linear convolution $\mathbf{x_1[n] * x_2[n]}$

$x_1[n] = [1; n = 0], [-2; n = 1]$ where $L_1 = 2$
$x_2[n] = [2; n = 0], [1; n = 1], [-1; n = 2]$ where $L_2 = 3$
$y[k] = h[n] * x[n] = \sum_{i=-k}^{L} x[i]h[k-i]$

$L = [2-1] + [3-1] = 3$

$y[0] = x_2[n] \bullet x_1[4-n]$:
$(x_2[0] \bullet x_1[0]) + (x_2[1] \bullet x_1[3]) + (x_2[2] \bullet x_1[2]) + (x_2[3] \bullet x_1[1]) = 2 \bullet 1 + 1 \bullet 0 + -1 \bullet 0 + 0 \bullet -2$
= 2

$y[1] = x_2[n] \bullet x_1[1-n]$:
$(x_2[0] \bullet x_1[1]) + (x_2[1] \bullet x_1[0]) + (x_2[2] \bullet x_1[3]) + (x_2[3] \bullet x_1[2]) = 2 \bullet -2 + 1 \bullet 1 + -1 \bullet 0 + 0 \bullet 0$ = -3

$y[2] = x_2[n] \bullet x_1[2-n]$:
$(x_2[0] \bullet x_1[2]) + (x_2[1] \bullet x_1[1]) + (x_2[2] \bullet x_1[0]) + (x_2[3] \bullet x_1[3]) = 2 \bullet 0 + 1 \bullet -2 + -1 \bullet 1 + 0 \bullet 0$
= -3

$y[3] = x_2[n] \bullet x_1[3-n]$:
$(x_2[0] \bullet x_1[3]) + (x_2[1] \bullet x_1[2]) + (x_2[2] \bullet x_1[1]) + (x_2[3] \bullet x_1[0]) = 2 \bullet 0 + 1 \bullet 0 + -1 \bullet -2 + 0 \bullet 1$
= 2

$$y[n] = \{2, -3, -3, 2\}$$

3.1.2 Compute 4-point DFT: $\mathbf{X_1[k]=DFT\{x_1[n]\}}$ and $\mathbf{X_2[k]=DFT\{x_2[n]\}}$.

Note:

a. DFT should be computed in numbers, following the DFT example provided
b. You can use Matlab to help in calculation, without using Matlab DFT function
c. Show all your steps.

$x_1[k] = \sum_{n=0}^{N-1} x_1[n] \bullet W_N^{k_n}$ where $N = 4$ and $W_N^{k_n} = e^{-j\frac{2\pi k_n}{N}}$

$x_1[0] = x_1[0] + x_1[1] + x_1[2] + x_1[3]$

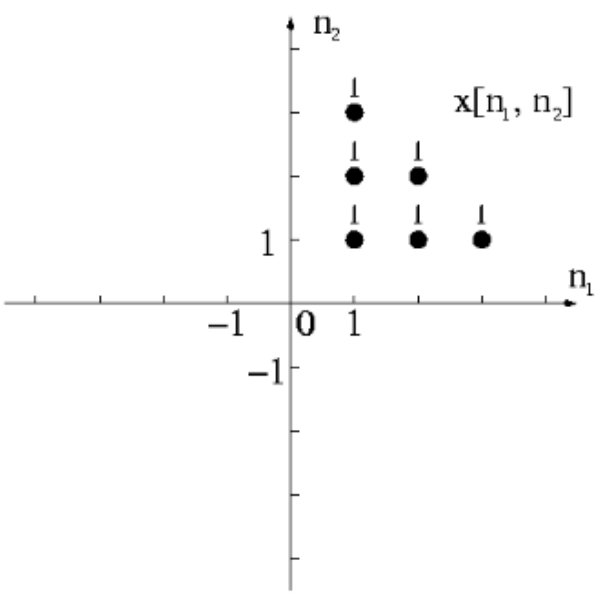
$x_1[0] = 1 - 2 = -1$
$x_1[1] = 1 + (-2)W_4^1 = 1 + (-2)(-j) = 1 + 2j$
$x_1[2] = 1 + (-2)W_4^2 = 1 + (-2)(-1) = 3$
$x_1[3] = 1 + (-2)W_4^3 = 1 + (-2)(j) = 1 - 2j$

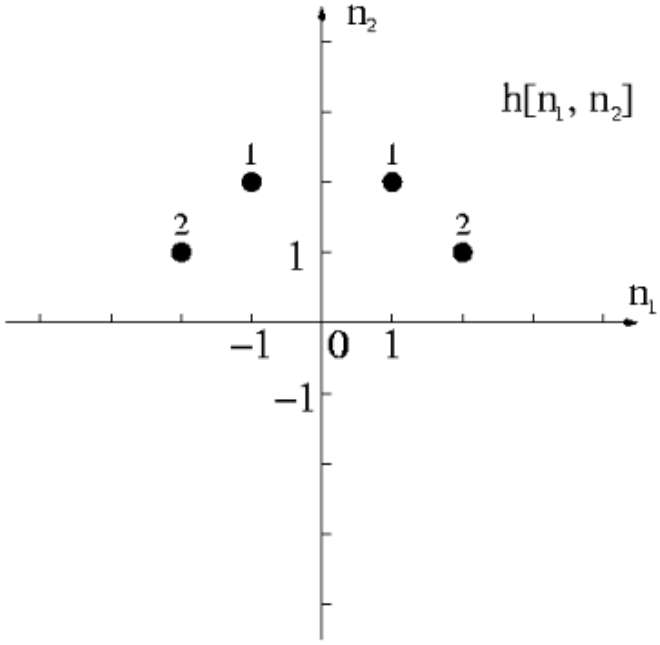
$x_2[k] = \sum_{n=0}^{3} x_2[n] \bullet W_4^{k_n}$

$x_2[0] = 2 + 1 - 1 = 2$
$x_2[1] = 2 + W_4^1 - W_4^2 + 0 = 2 - j + 1 = 3 - j$
$x_2[2] = 2 + W_4^2 - W_4^4 + 0 = 2 - 1 - 1 = 0$
$x_2[3] = 2 + W_4^3 - W_4^6 = 2 + j + 1 = 3 + j$

$$x_1[k] = \{-1, 1 + 2j, 3, 1 - 2j\}$$
$$x_2[k] = \{2, 3 - j, 0, 3 + j\}$$

3.2 (1A) Calculate the 2-D convolution **x[n,n]**h[n,n],** show all the necessary intermediate steps.





$y[n,n] = x[n,n] * h[n,n]$
$x[1,1] = x[1,2] = x[1,3] = 1$
$x[2,1] = x[2,2] = 1$
$x[3,1] = 1$

$h[-2,1] = h[2,1] = 2$
$h[-1,2] = h[1,2] = 1$

$y[-1,2] = x[1,1]h[-2,1] = 2$
$y[-1,3] = x[1,2]h[-2,1] = 2$
$y[-1,4] = x[1,3]h[-2,1] = 2$

$y[0,2] = x[2,1]h[-2,1] = 2$
$y[0,3] = x[1,1]h[-1,2] + x[2,2]h[-2,1] = 3$
$y[0,4] = x[1,2]h[-1,2] = 1$
$y[0,5] = x[1,3]h[-2,1] = 2$

$y[1,2] = x[3,1]h[-2,1] = 2$
$y[1,3] = x[2,1]h[-1,2] = 1$
$y[1,4] = x[2,2]h[-1,2] = 1$

$y[2,3] = x[1,1]h[1,2] + x[3,1]h[-1,2] = 2$
$y[2,4] = x[1,2]h[1,2] = 1$

$y[2,5] = x[1,3]h[1,2] = 1$

$y[3,2] = x[1,1]h[2,1] = 2$
$y[3,3] = x[1,2]h[2,1] + x[2,1]h[1,2] = 3$
$y[3,4] = x[1,3]h[2,1] + x[2,2]h[1,2] = 3$

$y[4,2] = x[2,1]h[2,1] = 2$
$y[4,3] = x[2,2]h[2,1] + x[3,1]h[1,2] = 3$

$y[5,2] = x[3,1]h[2,1] = 2$

$$y[n,n] = \{2, 2, 2, 2, 3, 1, 2, 2, 1, 1, 2, 1, 1, 2, 3, 3, 2, 3, 2\}$$