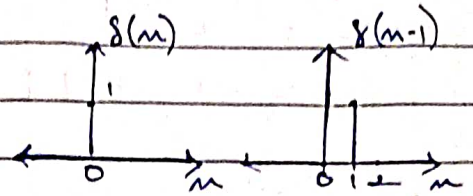
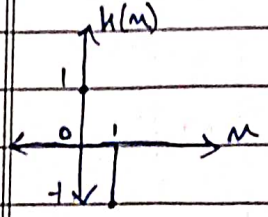
Digital Signal Processing

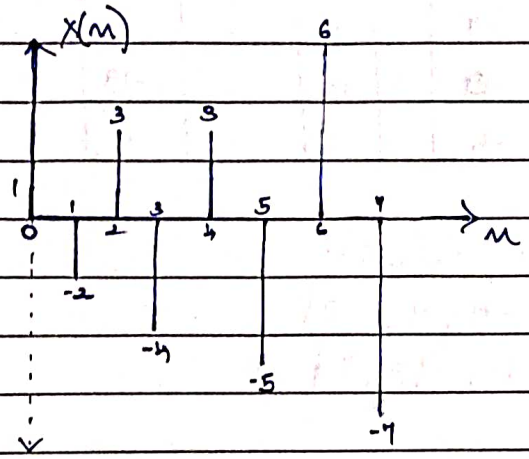
Assignment - 2

① $h(n) = \delta(n) - \delta(n-1)$





$x(n) = \delta(n) - 2\delta(n-1) + 3\delta(n-2) - 4\delta(n-3) + 3\delta(n-4) - 5\delta(n-5) + 6\delta(n-6) - 7\delta(n-7)$



$x(n) = \{1, -2, 3, -4, 3, -5, 6, -7\}$, $h(n) = \{1, -1\}$

Given $L = 3$; $M = 2$

$N = L + M - 1 = 3 + 2 - 1 = 4$

$x_1(n) = \{0, 1, -2, 3\}$

$x_2(n) = \{3, -4, 3, -5\}$

$x_3(n) = \{-5, 6, -7, 0\}$

$y_1(n) = x_1(n) \textcircled{N} h(n)$

$y_2(n) = x_2(n) \textcircled{N} h(n)$

$y_3(n) = x_3(n) \textcircled{N} h(n)$

$$\begin{bmatrix} 0 & 3 & -2 & 1 \\ 1 & 0 & 3 & -2 \\ -2 & 1 & 0 & 3 \\ 3 & -2 & 1 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} -3 \\ 1 \\ -3 \\ 5 \end{bmatrix}$$

$$\begin{bmatrix} 3 & -5 & 3 & -4 \\ -4 & 3 & -5 & 3 \\ 3 & -4 & 3 & -5 \\ -5 & 3 & -4 & 3 \end{bmatrix} \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 8 \\ -7 \\ 7 \\ -8 \end{bmatrix}$$

$$\begin{bmatrix} -5 & 0 & -7 & 6 \\ 6 & -5 & 0 & -7 \\ -7 & 6 & -5 & 0 \\ 0 & -7 & 6 & -5 \end{bmatrix} \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} -5 \\ 11 \\ -13 \\ 7 \end{bmatrix}$$

$y_1(n) = \{-3, 1, -3, 5\}$

$y_2(n) = \{8, -7, 7, -8\}$

$y_3(n) = \{-5, 11, -13, 7\}$

$y(n) = \{1, -3, 5, -7, 7, -8, 11, -13, 7\}$

(e) $x(t) = x(n T_s)$

$T_s = 1/f = 1/20$

$x(n) = \sin(10\pi n/20)$

$= \sin(\pi/2\, n)$

$x(0) = \sin(\pi/2(0)) = 0$ $\quad x(4) = \sin(2\pi) = 0$

$x(1) = \sin(\pi/2) = 1$ $\quad x(5) = \sin(2\pi + \pi/2) = 1$

$x(2) = \sin(\pi) = 0$ $\quad x(6) = \sin(3\pi) = 0$

$x(3) = \sin(\pi + \pi/2) = -1$ $\quad x(7) = \sin(3\pi + \pi/2) = -1$

$W_8^0 = e^{-j\frac{2\pi}{8}(0)} = 1$

$W_8^1 = e^{-j\frac{2\pi}{8}} = \cos(\pi/4) - j\sin(\pi/4) = \frac{1}{\sqrt{2}} - \frac{j}{\sqrt{2}}$

$W_8^2 = e^{-j\pi/4 \cdot 2} = \cos(\pi/2) - j\sin(\pi/2) = -j$

$W_8^3 = -\frac{1}{\sqrt{2}} - \frac{j}{\sqrt{2}}$

DIF

$x[0]=0$	$v[1]$	0	$F(0)$	0	0 $x[0]$
$x[1]=1$	$v[2]$	2	$F(1)$	0	0 $x[1]$
$x[2]=0$	$v[3]$	0	$W_8^0 F(2)$	0	$-4j$ $x[2]$
$x[3]=-1$	$v[4]$	-2	$W_8^2 F(3)$	$-4j$	$4j$ $x[3]$
$x[4]=0$	$W_8^0 v[5]$	0	$F(4)$	0	0 $x[4]$
$x[5]=1$	$W_8^1 v[6]$	0	$F(5)$	0	0 $x[5]$
$x[6]=0$	$W_8^2 v[7]$	0	$W_8^0 F(6)$	0	0 $x[6]$
$x[7]=-1$	$W_8^3 v[8]$	0	$W_8^2 F(7)$	0	0 $x[7]$

$v[1] = x[0] + x[4] = 0$

$v[2] = x[1] + x[2] = 2$

$v[3] = x[2] + x[6] = 0$

$v[4] = x[3] + x[7] = -2$

$v[5] = (x[0] - x[4]) W_8^0 = 0$

$v[6] = (x[1] - x[5]) W_8^1 = 0$

$v[7] = 0$

$v[8] = 0$

DTP

$x(0)=0$	$v_1(0)$	0	$F_1(0)$	0	0	$x(0)$
$x(4)=0$	$v_1(1)$	0	$F_1(1)$	0	0	$x(1)$
$x(2)=0$	$v_1(2)$	0	$F_1(2)$	0	4	$x(2)$
$x(6)=0$	$v_1(3)$	0	$F_1(3)$	0	0	$x(3)$
$x(1)=1$	$v_1(4)$	2	$F_1(4)$	$0\ w_8^0$	0	$x(4)$
$x(5)=1$	$v_1(5)$	0	$F_1(5)$	$0\ w_8^1$	0	$x(5)$
$x(3)=-1$	$v_1(6)$	-2	$F_1(6)$	$4\ w_8^2$	4	$x(6)$
$x(7)=-1$	$v_1(7)$	0	$F_1(7)$	$0\ w_8^3$	0	$x(7)$

$v_1(0)=0$ $v_1(4)=2$ $F_1(0)=0$ $F_1(4)=0$

$v_1(1)=0$ $v_1(5)=0$ $F_1(1)=0$ $F_1(5)=0$

$v_1(2)=0$ $v_1(6)=-2$ $F_1(2)=0$ $F_1(6)=4$

$v_1(3)=0$ $v_1(7)=0$ $F_1(3)=0$ $F_1(7)=0$

Magnitude