Assignment of DSP

DFT, FFT, Circular Convolution and digital filters(using notes)

1. Compute the DFT of the four-point sequence according to the generalized formulas of DFT.

$x(n) = (0 \quad 1 \quad 2 \quad 3)$

2. Compute the DFT and the IDFT of the four-point sequence by using matrix method

$x(n) = (0 \quad 1 \quad 2 \quad 3)$

3. Compute 4-point DFT of the sequence x[n]= {1,2,2,1}

- **Given the signal**:

$x[0]=1,\ x[1]=2,\ x[2]=2,\ x[3]=1,\ x[n]=0 \text{ otherwise} \rightarrow \mathbf{x}=[1,2,2,1]$

4. By means of the DFT and IDFT, determine the v sequence $x_3(n)$ corresponding to the circular convolution of the sequences $x_1(n)$ and $x_2(n)$ given below:

$$x_1(n) = \{\underset{\uparrow}{2}, 1, 2, 1\}$$

$$x_2(n) = \{\underset{\uparrow}{1}, 2, 3, 4\}$$

5. Consider the sequence

$$x(n) = \delta(n) + 2\delta(n-2) + \delta(n-3)$$

(a) Find the four-point DFT of *x (n).*

(b) If *y (n)* is the four-point circular convolution of *x (n)* with itself, find *y (n)* and the four-point DFT *Y (k).*

x (n) = { 1, 0, 2, 1}

6.

(a) Find the DFT $X[k]$ of $x[n] = \{0, 1, 2, 3\}$.

(b) Find the IDFT $x[n]$ from $X[k]$ obtained in part (a).

7. Given a sequence x[n] for
   $0 \le n \le 3$, where $x(0) = 1$, $x(1) = 2$, $x(2) = 3$, and $x(3) = 4$,
   a) evaluate its DFT X[k] using four-point FFT using decimation-in-time and decimation-in-frequency FFT method;
   b. determine the number of complex multiplications.

Part 2. Tutorial on FFT

1. Sketch the butterflies diagram and compute 4-Point DFT of a sequence x[n] = {1, 2, 3, 0} using DIT algorithm and DIF algorithm.
2. Given a sequence
   $x(n)$ for $0 \le n \le 3$, where $x(0) = 1, x(1) = 2, x(2) = 3$, and $x(3) = 4$,
   evaluate its DFT X (k) using the decimation-in-time FFT method.

3. Given the DFT sequence $X(k)$ for $0 \leq k \leq 3$ computed above, evaluate its inverse DFT x[n] using the decimation-in-time FFT method.

4. Given a sequence
$x(n)$ for $0 \leq n \leq 3$, where $x(0) = 1$, $x(1) = 2$, $x(2) = 3$, and $x(3) = 4$,
a. evaluate its DFT X(k) using the decimation-in-frequency FFT method;
b. determine the number of complex multiplications.

5. Given the DFT sequence $X(k)$ for $0 \leq k \leq 3$ with X (k) = {10, -2 +2j, -2, -2-2j}

evaluate its inverse DFT x[n] using the decimation-in-frequency FFT method.

Part III Filters

1. $Y(z) = 0.1X(z) + 0.25X(z)z^{-1} + 0.2X(z)z^{-2}$

$H(z) = Y(z)/X(z) = 0.1 + 0.25\, z^{-1} + 0.2z^{-2}$

What kind of filter is it? Implement it.

2. What kind of filter is it? Implement it.

$$H(z) = \frac{1+2z^{-1}}{1-1.5z^{-1}+0.9z^{-2}}$$

3. A linear phase FIR filter has seven coefficients which are listed below. Draw the realization diagrams for the filter using the direct Form I (transversal)

$$h(0) = h(6) = -0.032$$

$$h(1) = h(5) = 0.038$$

$$h(2) = h(4) = 0.048$$

$$h(3) = -0.048$$

4.

Given the FIR filter

$$y(n) = 0.1x(n) + 0.25x(n-1) + 0.2x(n-2)$$

determine the transfer function, filter length, nonzero coefficients, and impulse response.

5.

Given the IIR filter

$$y(n) = 0.2x(n) + 0.4x(n-1) + 0.5y(n-1)$$

determine the transfer function, nonzero coefficients, and impulse response.

6. What kind of filters is it and why? Give the stability requirement for that filter.
7. Sketch the block diagram representation of the discrete time system described by the input-output relation

$$y(n) = \frac{1}{4}\, y(n-1) + \frac{1}{2}\, x(n) + \frac{1}{2}\, x(n-1)$$

Where $x(n)$ is the input and $y(n)$ is the output of the system.