Digital Signal Processing Ⅱ

7^{th} EXPERIMENT

Report

(7th report of DSP2 course)

Subject	Digital Signal Processing Ⅱ
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Exercises

In this part, there are several exercise questions. Each exercise consists of code and its result. All documents including MATLAB code, result, and this report are uploaded in this website :

https://github.com/Gaon-Choi/ELE3077/tree/main/lab_experiment07

Exercise 1

Let $x[n]$ be a 4-point sequence:

$$x[n] = \begin{cases} 1, & 0 \le n \le 3 \\ 0, & \text{otherwise} \end{cases}$$

And the discrete-time Fourier transform of $x[n]$ is given by

$$X(e^{j\Omega}) = \sum_{0}^{3} x[n]e^{-j\Omega n} = 1 + e^{-j\Omega} + e^{-j2\Omega} + e^{-j3\Omega}$$

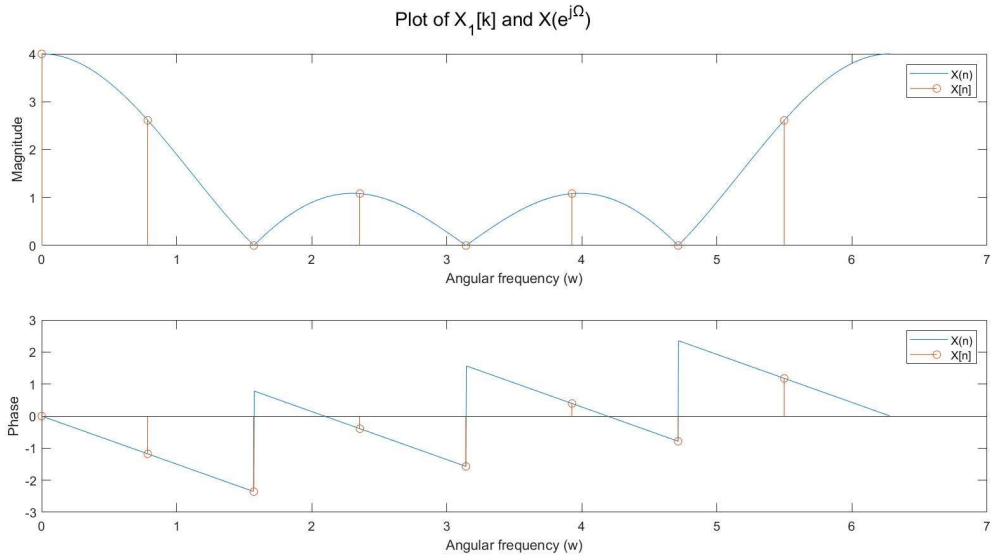
Calculate $X_1[k]$ which is the 8-point DFT of $x[n]$ and plot magnitude and phase graphs of $X(e^{j\Omega})$ and $X_1[k]$ on the same plane. (Use stem function for X_1 and plot function for X with frequency angular axis).

(MATLAB Code) lab7_exercise1.m

```
n = 0:7;
N = length(n);

k = 0:N-1;
x = [1 1 1 1 0 0 0 0];
X = dft(x);

magX = abs(X);
angX = angle(X);

Xw = ((2*pi)/N) * k;
yw = ((2*pi)/2000)*[0:1999];
Y = 1 + exp(-j .* yw) + exp(-2*j .* yw) + exp(-3*j .* yw);

subplot(2, 1, 1);
plot(yw, abs(Y));
hold on
stem(Xw, magX);
xlabel("Angular frequency (w)"); ylabel("Magnitude");
```

```
legend('X(n)', 'X[n]');

subplot(2, 1, 2);
plot(yw, angle(Y));
hold on
stem(Xw, angX);
xlabel("Angular frequency (w)"); ylabel("Phase");
legend('X(n)', 'X[n]');

sgtitle("Plot of X_1[k] and X(e^j^¥Ø)");
```

(Result)



Exercise 2

Let $x[n]$ be a sequence $x[n] = (0.95)^n \cos\left(\frac{\pi}{20}n\right)$ for $0 \leq n \leq 63$.

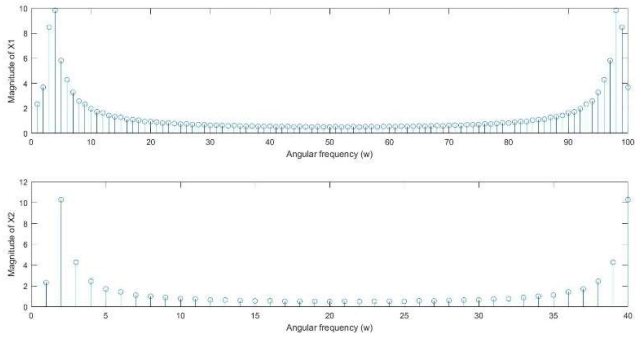
Question A.

Generate the sequence X_1 and X_2 that discrete-time Fourier transform sampled with $M_1 = 100$ and $M_2 = 40$ from 0 to 2π, respectively. And plot these magnitudes with frequency angular axis by using stem function.

(MATLAB Code) lab7_exercise2_a.m

```
n = 0:63;
x = ((0.95).^n).*cos((pi/20)*n);

M1 = 100; M2 = 40;
k1 = [0:M1-1]; k2 = [0:M2-1];
DT_samp = @(x, k, n) x*(exp(-1j * 2 * pi /
length(k))).^(n'*k);

X1 = DT_samp(x, k1, n);
X2 = DT_samp(x, k2, n);

magX1 = abs(X1);
magX2 = abs(X2);

subplot(2, 1, 1);
stem(magX1);
xlabel("Angular frequency (w)"); ylabel("Magnitude of X1");

subplot(2, 1, 2);
stem(magX2);
xlabel("Angular frequency (w)"); ylabel("Magnitude of X2");
```

(Result)



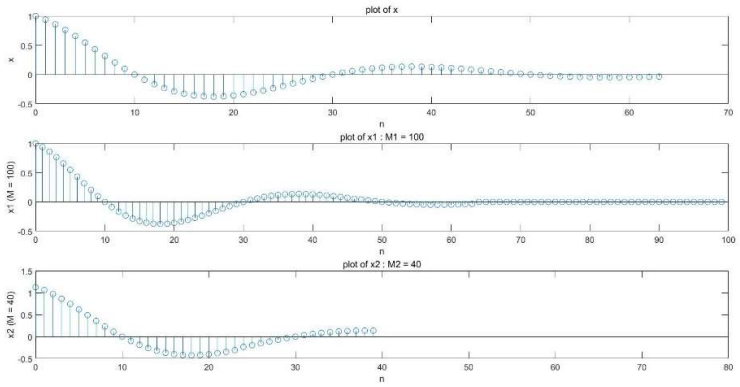
Question B.

Calculate x_1 and x_2 that is inverse discrete Fourier transform of X_1 and X_2 respectively by using idft function (You create this m-file in last week's experiment). Plot sequence x, x_1 and x_2. And, compare each of them and explain it.

(MATLAB Code) lab7_exercise2_b.m

```
n = 0:63;
x = ((0.95).^n).*cos((pi/20)*n);

M1 = 100; M2 = 40;
k1 = [0:M1-1]; k2 = [0:M2-1];
DT_samp = @(x, k, n) x*(exp(-1j * 2 * pi /
length(k))).^(n'*k);

X1 = DT_samp(x, k1, n);
X2 = DT_samp(x, k2, n);

x1 = idft(X1); x2 = idft(X2);

subplot(3, 1, 1);
stem(n, x); xlabel("n"); ylabel("x");
title("plot of x");

subplot(3, 1, 2);
stem(k1, real(x1));
xlabel("n"); ylabel("x1 (M = 100)"); xlim([0 100]);
title("plot of x1 : M1 = 100");

subplot(3, 1, 3);
stem(k2, real(x2));
xlabel("n"); ylabel("x2 (M = 40)"); xlim([0 80]);
title("plot of x2 : M2 = 40");
```

(Result)



Question C.

Calculate $\widetilde{x_1}$ and $\widetilde{x_2}$ that is inverse discrete Fourier series of X_1 and X_2 respectively using idfs function. Plot sequence x, x_1 and x_2 on one period. And, compare each of them and explain it.

(MATLAB Code) lab7_exercise2_c.m

```
n = 0:63;
x = ((0.95).^n).*cos((pi/20)*n);

M1 = 100; M2 = 40;
k1 = [0:M1-1]; k2 = [0:M2-1];
DT_samp = @(x, k, n) x*(exp(-1j * 2 * pi /
length(k))).^(n'*k);

X1 = DT_samp(x, k1, n);
X2 = DT_samp(x, k2, n);

x1 = idfs(X1);
x2 = idfs(X2);

subplot(3, 1, 1);
plot(n, x); xlabel("n"); ylabel("x"); xlim([0 63]);
title("plot of x");

subplot(3, 1, 2);
plot(0:M1*4-1, real(x1)); xlabel("n"); ylabel("x1 (M1 =
100)"); xlim([0 M1]);
title("plot of x1 : M1 = 100");

subplot(3, 1, 3);
plot(0:M2*4-1, real(x2)); xlabel("n"); ylabel("x2 (M2 =
40)"); xlim([0 M2]);
title("plot of x2 : M2 = 40");
```

(Result)