Republic of Iraq

Ministry of Higher Education

and Scientific Research

Al-Mustaqbal University College

Computer Engineering Techniques Department

(عملي)

Subject: Digital Signal Processing

Third stage

By

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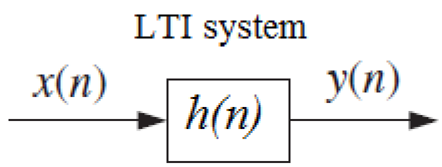
Experiment No.

Name of Experiment: Impulse Response of the LTI System

Aim: analysis the impulse response of a LTI system defined by a difference equation:

Theory:-

The special type of discrete system is the linear time invariant (LTI) system where the linearity property is combined with the time invariant property in this system. LTI systems are of fundamental importance in practical analysis firstly because they are relatively simple to analyze and secondly because they provide reasonable approximations to many real-world systems.



The output can be calculated by convolution operation between the input and the LTI system response:

$$y(n) = x(n) * h(n)$$

There are two approaches to analyzing signals and systems: the time-domain approach and the frequency-domain approach. The two approaches are equivalent, with both domains being connected by the well known Fourier transform.

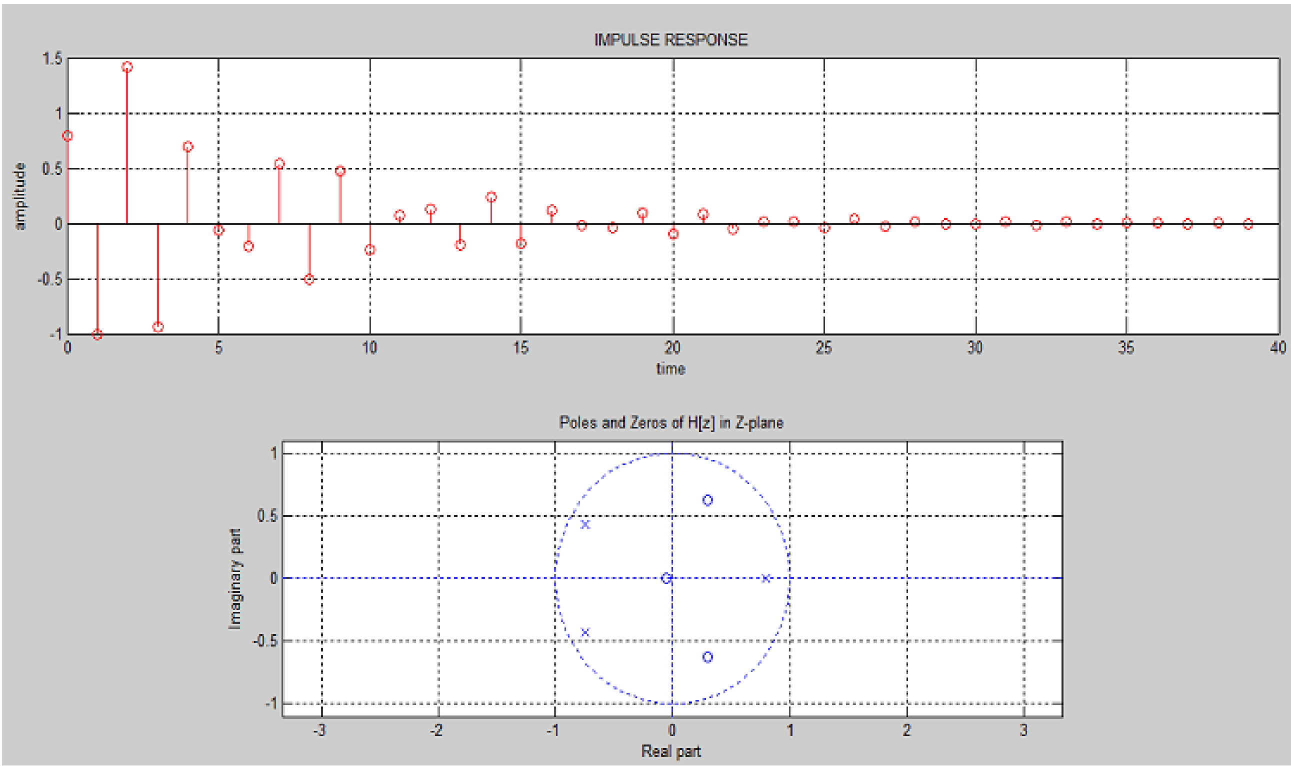
Procedure:

```
clc;
clear all;
close all;
N = input ('Enter the required length of impulse response N = ');
n = 0 : N-1;
b = input ('Enter the co-efficients of x(n), b = ');
a = input ('Enter the co=efficients of y(n), a = ');
% Impulse response of the LTI system given by the difference equation
x = [1, zeros(1,N-1)];
y = impz (b,a,N);
subplot (2,1,1);
stem (n,y,'r');
xlabel ('time');
ylabel ('amplitude');
title ('IMPULSE RESPONSE');
grid on;
% Pole – Zero distribution of the LTI system given by the difference equation
subplot (2,1,2);
zplane (b,a);
xlabel ('Real part');
ylabel ('Imaginary part');
title ('Poles and Zeros of H[z] in Z-plane');
grid on;
```

Result

Output :

Enter the required length of impulse response N = 40
Enter the co-efficients of x(n), b = [0.8 -0.44 0.36 0.02]
Enter the co=efficients of y(n), a = [1 0.7 -0.45 -0.6]



Experiment No.9

Name of Experiment: Frequency Response of The LTI System

Aim: analysis the frequency response of a LTI system defined by a difference equation:

Theory:-

The frequency response of the LTI system can be found by taking the Fourier transform in the form of a discrete Fourier transform of the LTI impulse response. Fourier transform considered here is strictly speaking the **discrete-time Fourier**

transform (DTFT). The frequency response of H , denoted $H\left(e^{j\omega}\right)$, is defined as the DTFT of $h[n]$:

$$H\left(e^{j\omega}\right) = \sum_{k=-\infty}^{\infty} h(k)\, e^{-j\omega k}$$

And the output of LTI system is:

$$Y\left(e^{j\omega}\right) = H\left(e^{j\omega}\right) X\left(e^{j\omega}\right)$$

where $Y\left(e^{j\omega}\right),\ X\left(e^{j\omega}\right) \quad and\ \ H\left(e^{j\omega}\right)$ are the Fourier transforms of ***y[n], x[n],*** and ***h[n],*** respectively. we have relationships represented by polar form:

$$H\left(e^{j\omega}\right) = \left|H\left(e^{j\omega}\right)\right| e^{j\theta(\omega)}$$

As in the continuous-time case, the function $H\left(e^{j\omega}\right)$ is called the ***frequency response*** of the system, $\left|H\left(e^{j\omega}\right)\right|$ the ***magnitude response*** of the system, and $\theta(\omega)$ the ***phase response*** of the system.

Procedure

y(n) – 5 y(n–1) = x(n) + 4 x(n–1)

```
b = [1, 4]; %Numerator coefficients
a = [1, -5]; %Denominator coefficients
w = -2*pi: pi/256: 2*pi;
% Frequency Response of the LTI system
[h] = freqz(b, a, w);
subplot(2, 1, 1),
plot(w, abs(h));
xlabel ('Frequency \omega'),
ylabel ('Magnitude');
grid on;
% Phase Response of the LTI system
subplot(2, 1, 2),
```

```
plot(w, angle(h));
xlabel('Frequency \omega'),
ylabel('Phase - Radians');
grid on;
```

Result

Output: