ACTIVITY 7

DFT and IDFT

I. DISCRETE FOURIER TRANSFORM (DFT)

The discrete Fourier transform of a length N signal $x[n]$, $n = 0, 1, \ldots, N - 1$ is given

$$X[k] = \sum_{n=0}^{N-1} x[n] e^{-j(2\pi/N)kn}$$

by

It can be represented as

$$X[k] = \sum_{n=0}^{N-1} x[n] W_N^{kn}$$

Where,

$$W_N = e^{-j(2\pi/N)}$$

MATLAB function for DFT:

```
function [ Xk ] = disc_fourier_transform( xn, N )
    n=[0:1:N-1];
    k=[0:1:N-1];
    WN=exp(-1j*2*pi/N);
    nk= n'*k;
    WNnk=WN .^ nk;
    Xk= xn*WNnk;
end
```

II. INVERSE DISCRETE FOURIER TRANSFORM

$$x[n] = \frac{1}{N} \sum_{k=0}^{N-1} X[k] e^{j(2\pi/N)kn}.$$

To make it simple,

$$x[n] = \frac{1}{N} \sum_{k=0}^{N-1} X[k] W_N^{-kn}$$

MATLAB Function for IDFT:

```
function [ xn ] = inverse_dft( Xk, N )
    n=[0:1:N-1];
    k=[0:1:N-1];
    WN=exp(-1j*2*pi/N);
    nk=n'*k;
    WNnk=WN.^(-nk);
    xn=(Xk*WNnk)/N;
end
```

III. MATLAB EXERCISES

1. Generate a random signal x[n] with 100 samples using the **rand/randi** function. Plot the signal x[n].
2. Determine the DFT X[k] of x[n] in number 1 using the **disc_fourier_transform** function. Plot the real and imaginary of the DFT X[k].
3. Plot the magnitude and phase of the DFT X[k].
4. Determine the IDFT x[n] in number 2 using the **inverse_dft** function. Plot the signal **x[n]** generated by the **inverse_dft** function.

Note: Make sure to provide proper labels in plotting of the signals.