DFT AND IDFT

MATLAB CODE:-- DFT

```matlab
x=input("Enter the x[n]");
N=input('Enter the Number of points of DFT');
Xk=calcdft(x,N);
disp('DFT X(k)=');
disp(Xk)
%magnitude of DFT
magxk=abs(Xk);

%phase of DFT
phasexk=angle(Xk);

%plots
k=0:N-1;

subplot(2,1,1);
stem(k,magxk);
xlabel('k');
ylabel('|X[k]|');
title('Magnitude Spectrum');

subplot(2,1,2);
stem(k,phasexk);
xlabel('k');
ylabel('<X[k]');
title('Phase Spectrum');
```

calcdft.m

```matlab
function [Xk]=calcdft(x,N)
    L=length(x); %length of seq x(n)

    if(N<L)
        error("N must be greater than or equal to L");
    end
    if N>=L    %Error Message
        x1=[x zeros(1,(N-L))];
    end

    %construct the Matrix

    for k=0:N-1
        for n=0:N-1
            p=exp(-i*2*pi*k*n/N);    %fiddle factor
            T(k+1,n+1)=p;
        end
    end
    disp("Transformation matrix for dft");
    disp(T);
    Xk=T*x1';
end
```
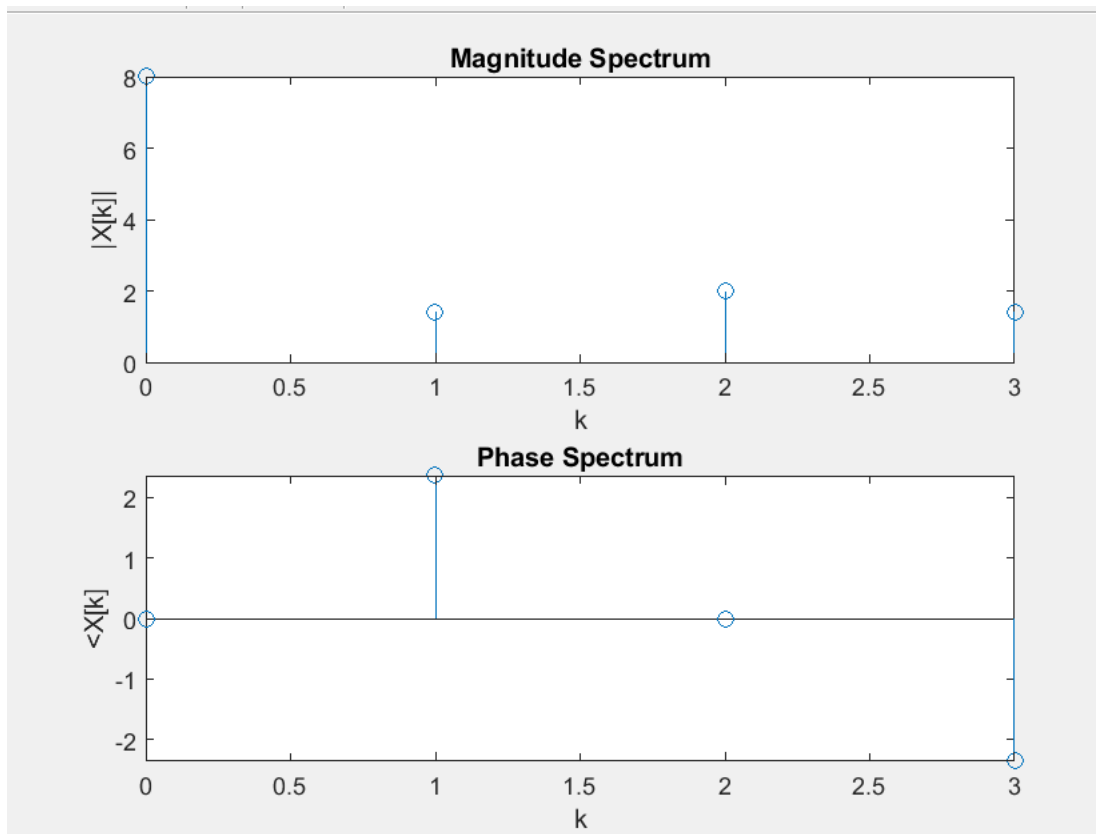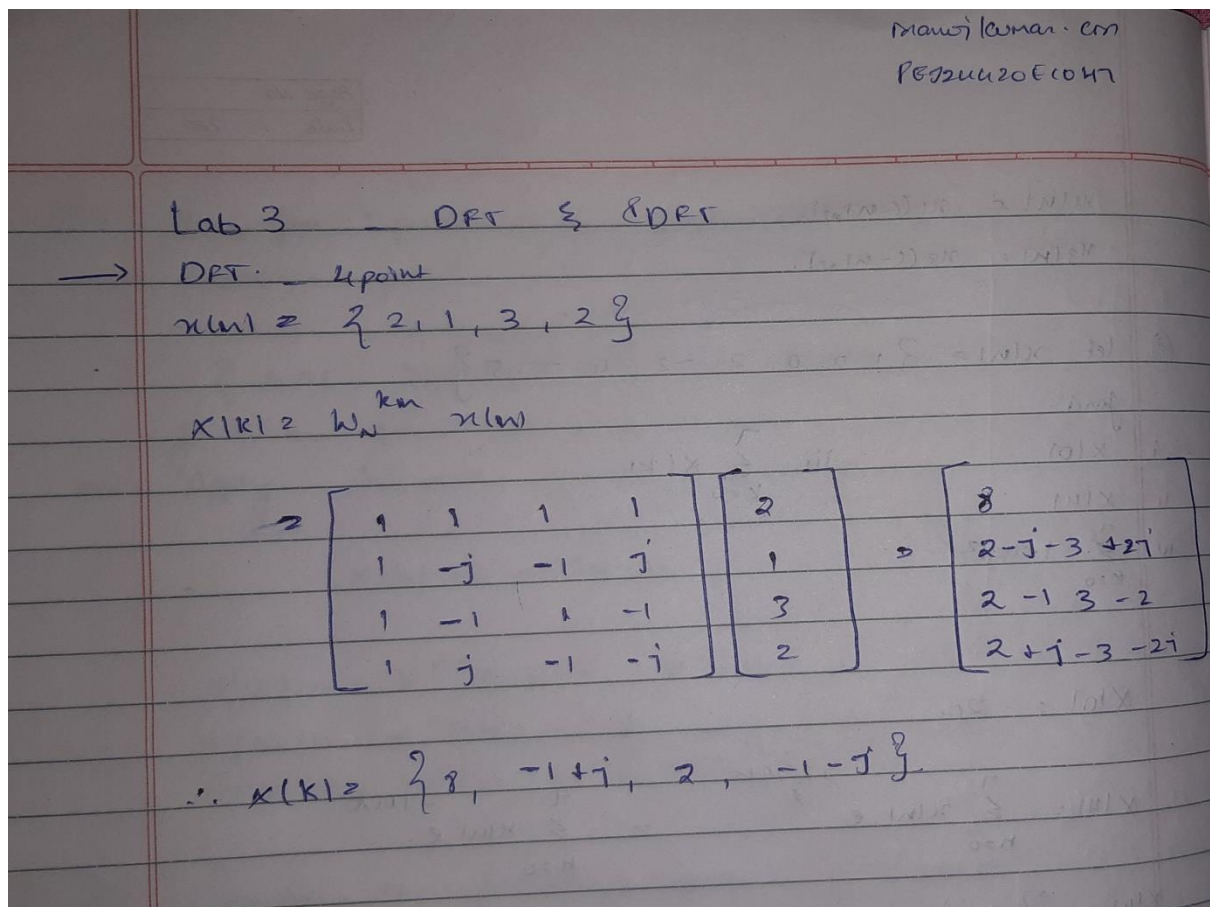
Terminal Output:

```
>> exp3a
Enter the x[n][2 1 3 2]
Enter the Number of points of DFT4
Transformation matrix for dft
   1.0000 + 0.0000i    1.0000 + 0.0000i    1.0000 + 0.0000i    1.0000 + 0.0000i
   1.0000 + 0.0000i    0.0000 - 1.0000i   -1.0000 - 0.0000i   -0.0000 + 1.0000i
   1.0000 + 0.0000i   -1.0000 - 0.0000i    1.0000 + 0.0000i   -1.0000 - 0.0000i
   1.0000 + 0.0000i   -0.0000 + 1.0000i   -1.0000 - 0.0000i    0.0000 - 1.0000i

DFT X(k)=
   8.0000 + 0.0000i
  -1.0000 + 1.0000i
   2.0000 - 0.0000i
  -1.0000 - 1.0000i
```

Plot:

Theoretical Calculations:

MATLAB CODE:--IDFT

```
Xk=input("Enter the DFT seq");
x=calcidft(Xk);
N=length(x);
disp("The Sequence x[n]:");
disp(x);

%plots
n=0:N-1;
stem(n,x);
xlabel('time');
ylabel('Amp');
title('i/p sequence');
```

calcidft.m

```
function [x]=calcidft(Xk)
    N=length(Xk);
    for k=0:N-1
        for n=0:N-1
            p=exp(i*2*pi*k*n/N);    %fiddle factor
            IT(k+1,n+1)=p;
        end
    end
```

```
    disp('Transformation Matrix is');
    disp(IT);
    x=(IT*(Xk).')./N;
end
```
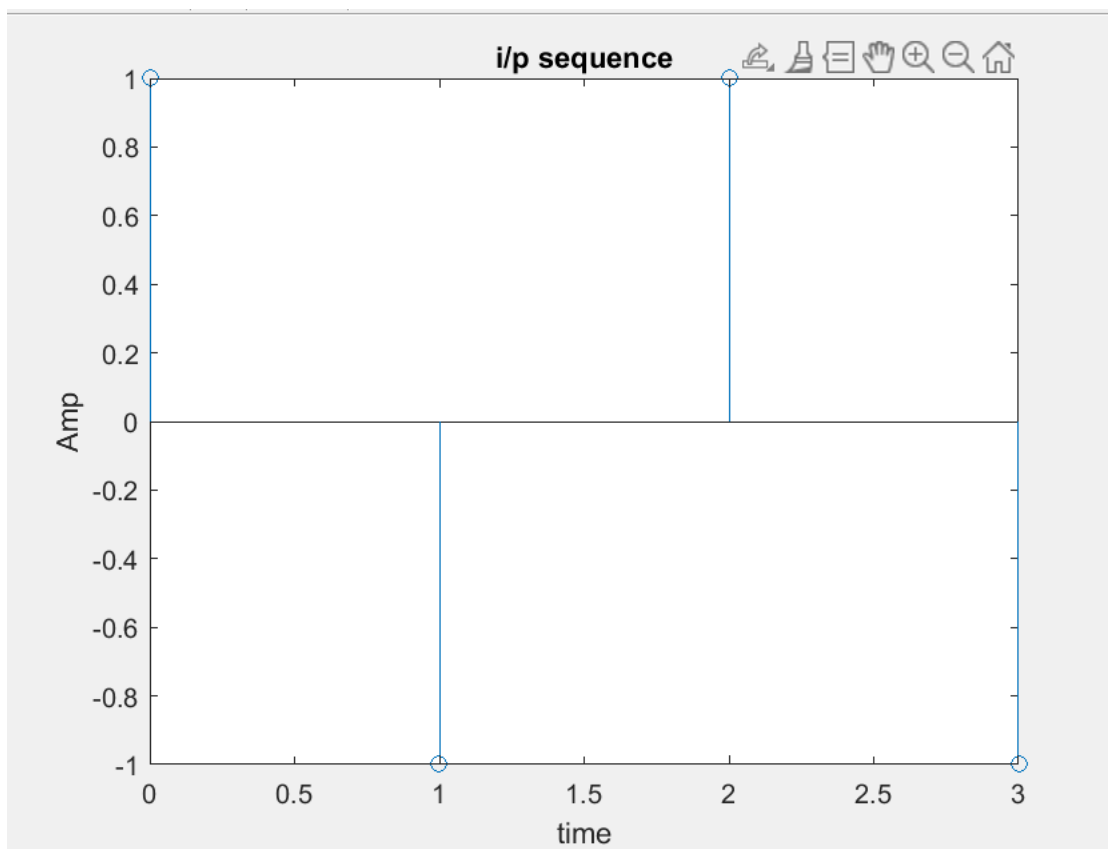
Terminal Output:

```
>> exp3b
Enter the DFT seq[ 0 0 4 0]
Transformation Matrix is
   1.0000 + 0.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i
   1.0000 + 0.0000i   0.0000 + 1.0000i  -1.0000 + 0.0000i  -0.0000 - 1.0000i
   1.0000 + 0.0000i  -1.0000 + 0.0000i   1.0000 - 0.0000i  -1.0000 + 0.0000i
   1.0000 + 0.0000i  -0.0000 - 1.0000i  -1.0000 + 0.0000i   0.0000 + 1.0000i

The Sequence x[n]:
   1.0000 + 0.0000i
  -1.0000 + 0.0000i
   1.0000 - 0.0000i
  -1.0000 + 0.0000i
```

Plot:

Theoretical Calculations:

ii) $x(k) = \{0, 0, 4, 0\}$

$$x(n) = \frac{1}{N} \sum_{k=0}^{N-1} x(k)\, e^{+j\frac{2\pi}{N}kn}$$

$$x(0) = \frac{1}{4}\left[x(0)\, e^{+j\frac{2\pi}{4}(0)(0)} + x(1)\, e^{+j\frac{2\pi}{4}(1)(0)} + x(2)\, e^{+j\frac{2\pi}{4}(2)(0)} + x(3)\, e^{+j\frac{2\pi}{4}(3)(0)} \right]$$

$$= \frac{1}{4}[4] = 0.$$

$$x(1) = \frac{1}{4}\left[x(0)\, e^{+j\frac{2\pi}{4}(0)(1)} + x(1)\, e^{+j\frac{2\pi}{4}(1)(1)} + x(2)\, e^{+j\frac{2\pi}{4}(2)(1)} + x(3)\, e^{+j\frac{2\pi}{4}(3)(1)} \right]$$

$$= \frac{1}{4}\left[4\, e^{j\pi} \right] = -1.$$

$$x(2) = \frac{1}{4}\left[x(0)\, e^{+j\frac{2\pi}{4}(2)(0)} + x(1)\, e^{+j\frac{2\pi}{4}(0)(1)} + x(2)\, e^{+j\frac{2\pi}{4}(2)(2)} + x(3)\, e^{+j\frac{2\pi}{4}\cdot3\cdot2} \right]$$

$$x(2) = \frac{1}{4}(4 \cdot 1) = 1.$$

$$x(3) = \frac{1}{4}\left[x(0)\, e^{+j\frac{2\pi}{4}(3)(0)} + x(1)\, e^{+j\frac{2\pi}{4}(3)(1)} + x(2)\, e^{+j\frac{2\pi}{4}(3)(2)} + x(3)\, e^{+j\frac{2\pi}{4}\cdot3\cdot3} \right]$$

$$= \frac{1}{4}\left[4\,(-1) \right] = -1$$

$$\therefore x(n) = \{1, -1, 1, -1\}.$$