ASSIGNMENT-2

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AIM:- Evaluate DTFT of the signal (a^n)*u(n) using MATLAB. First check whether DTFT exists or not.

Theory:-

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$x[n] = a^n u[n]$

will exist when $|a|<1$

$$\sum_{n} |x[n]| = \sum_{n=0}^{\infty} a^n = \frac{1}{1-a} < \infty$$

Now to compute the DTFT we have the DTFT formula as

$$X_{DTFT}(\omega) = \sum_{n=-\infty}^{\infty} x[n]\, e^{-j\omega n}$$

$$= \sum_{n=-\infty}^{\infty} a^n u[n] \cdot e^{-j\omega n}$$

$$= \sum_{n=0}^{\infty} a^n e^{-j\omega n} \quad \left[u(n) = \begin{cases} 0 & n<0 \\ 1 & n \geq 0 \end{cases}\right]$$

$$= \sum_{n=0}^{\infty} (a e^{-j\omega})^n \quad \{\text{series in a infinite GP}\}$$

$$X_{DTFT}(\omega) = \frac{1}{1-ae^{-j\omega}} \quad \text{for } (|a|<1)$$

Discrete time fourier transform of a discrete sequence of real or complex numbers $x[n]$ for $n \in Z$ is a fourier series which produce a periodic function of a frequency variable. It has a periodicity of 2π. Formula for DTFT is

$$X_{2\pi}(\omega) = \sum_{n=-\infty}^{\infty} x[n]\, e^{-j\omega n}$$

Code:-

```
a=input ('Value of a:');
N=input('Size of x[n]:');
x=zeros (1,N);
j=0;

%computing x[n]

for i=1:N
   x(i)=a^(j);
   j=j+1;
end

%computing X (w)

w=0;
X=zeros(1,N);

for i=1:N
   d=0;
   k=0;
    for j=1:N
    d=d+x(j)*exp(-1i*w*k);
    k=k+1;
    end
  X(i)=d;
  w=w+1;
  end
disp(X);
```

OUTPUT:-

```
Command Window
>> dsp
Value of a:1
Size of x[n]:5
  Columns 1 through 4

   5.0000 + 0.0000i  -0.5195 - 1.1351i   0.7449 - 0.8624i   0.9029 + 0.2627i

  Column 5

   0.0871 + 0.5919i
```

....

AIM:- Prove the following properties of DTFT using MATLAB: Linearity, Scaling, Time-reversal, Time-Shifting, Frequency-Shifting.

SOFTWARE USED:-MATLAB

1. **The linearity property of DTFT -**

```
clc;
clear all;
close all;
N=100; %length of signal
n=0:N-1
M=200; %length of frequency vector
alpha=3;
beta=4;
k=0:M;
w=(pi/M)*k;
x1=randn(1,N);
x2=randn(1,N);
X1=x1*(exp(-1j*pi/M).^(n' *k));
X2=x2*(exp(-1j*pi/M).^(n' *k));
x=alpha*x1+beta*x2;
X=x*(exp(-1j*pi/M).^(n' *k));
%For Verification
X_check=alpha*X1+beta*X2;
```

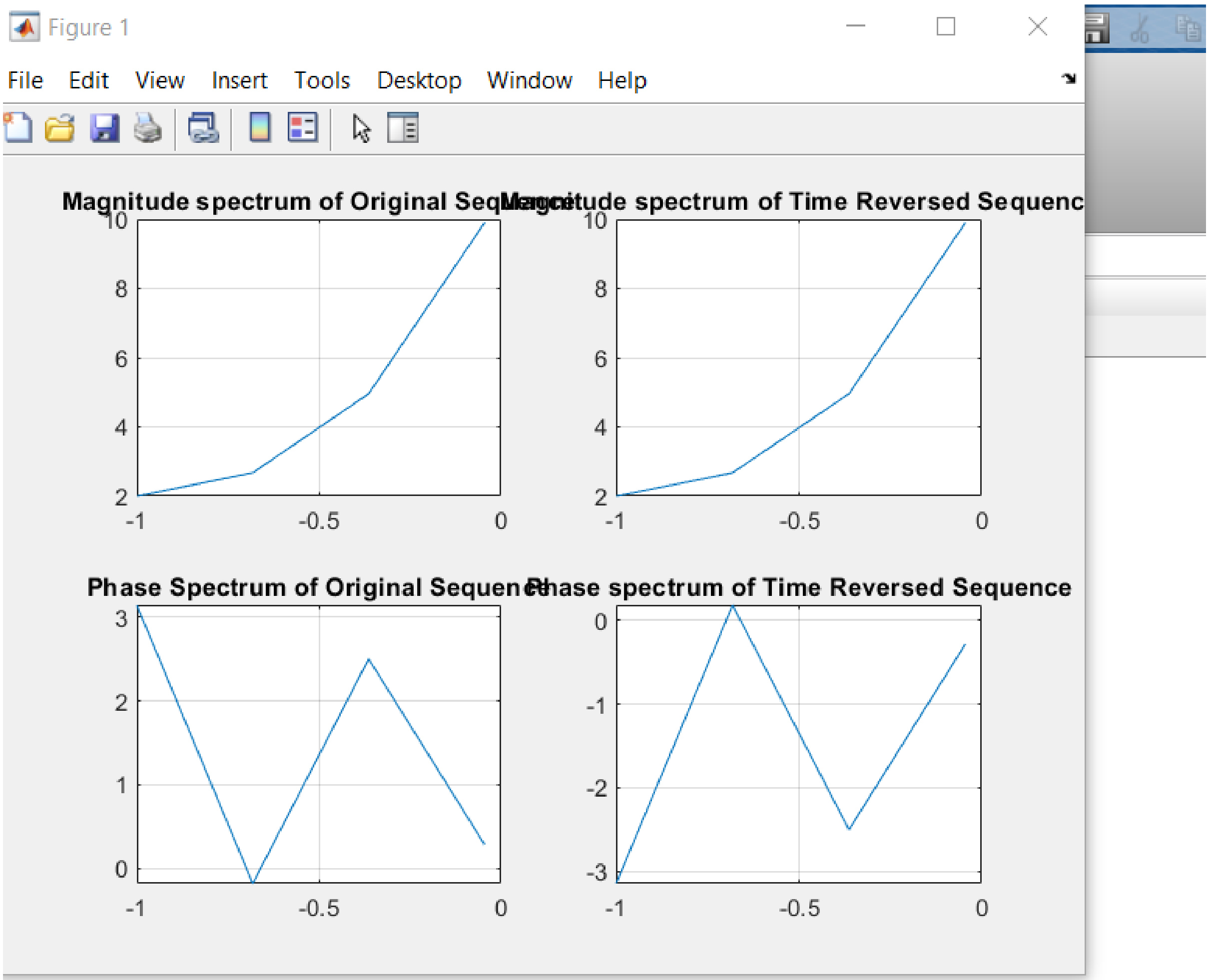
OUTPUT:-

```
Command Window

n =

  Columns 1 through 13

     0     1     2     3     4     5     6     7     8     9    10    11    12

  Columns 14 through 26

    13    14    15    16    17    18    19    20    21    22    23    24    25

  Columns 27 through 39

    26    27    28    29    30    31    32    33    34    35    36    37    38

  Columns 40 through 52

    39    40    41    42    43    44    45    46    47    48    49    50    51

  Columns 53 through 65

    52    53    54    55    56    57    58    59    60    61    62    63    64

  Columns 66 through 78
```

2. **Time reversal property of DTFT –**

```
clc;
clear all;
close all;
w=-pi:2*pi/255*pi;
num=[1 2 3 4];
L=length(num)-1;
h1=freqz(num,1,w);
h2=freqz(fliplr(num),1,w);
h3=exp(w*L*i).*h2;
subplot(2,2,1)
plot(w/pi,abs(h1)); grid
title('Magnitude spectrum of Original Sequence')
subplot(2,2,2)
plot(w/pi,abs(h3)); grid
title('Magnitude spectrum of Time Reversed Sequence')
subplot(2,2,3)
plot(w/pi,angle(h1)); grid
title('Phase Spectrum of Original Sequence')
subplot(2,2,4)
plot(w/pi,angle(h3)); grid
title('Phase spectrum of Time Reversed Sequence')
```

OUTPUT:-



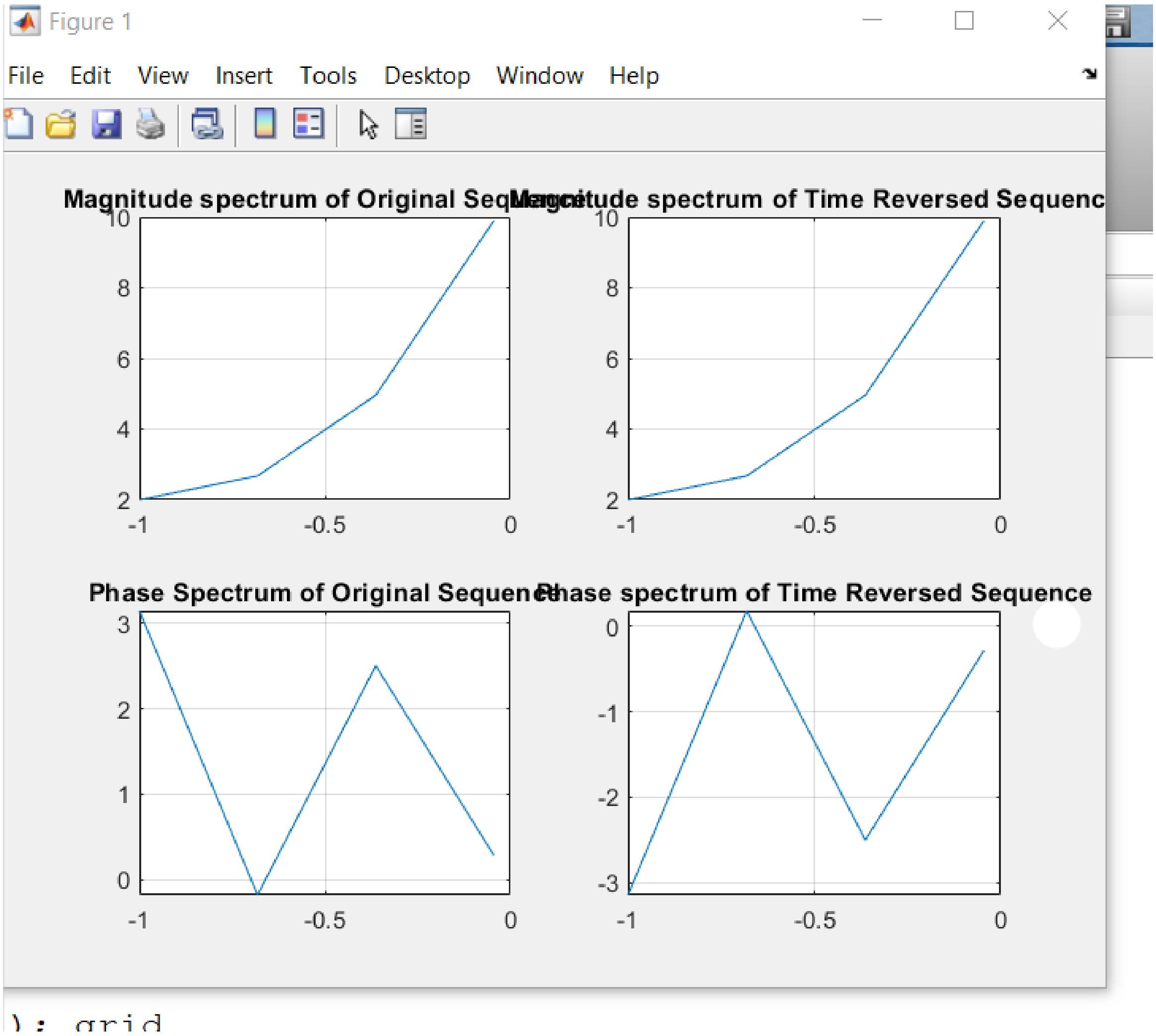

```
); grid
```

3. Frequency shifting property of DTFT –

```
clc;
clear all;
close all;
w=-pi:2*pi/255*pi;
wo=0.4*pi;
num=[1 2 3 4 5 6 7];
L=length(num);
h1=freqz(num,1,w);
n=0:L-1;
num1=exp(wo*i*n).*num;
h2=freqz(num1,1,w);
subplot(2,2,1)
plot(w/pi,abs(h1)); grid
title('Magnitude spectrum of Original Sequence')
subplot(2,2,2)
plot(w/pi,abs(h2)); grid
title('Magnitude spectrum of Frequency Shifted Sequence')
subplot(2,2,3)
plot(w/pi,angle(h1)); grid
```

```
title('Phase Spectrum of Original Sequence')
subplot(2,2,4)
plot(w/pi,angle(h2)); grid
title('Phase spectrum of Frequency Shifted Sequence')
```

OUTPUT:-



4. **The time shifting property of DTFT –**

```
clc, clear all, close all;
x=rand(1,21);
n=0:20;
k=0:20;w=(pi/20)*k;
X=x*(exp(-1i*pi/500*n'*k));
y=x;m=n+2;
Y=y*(exp(-1i*pi/500*n'*k));
subplot(1,2,1);plot(n,abs(X));
subplot(1,2,2);plot(m,abs(Y));
```

OUTPUT:-

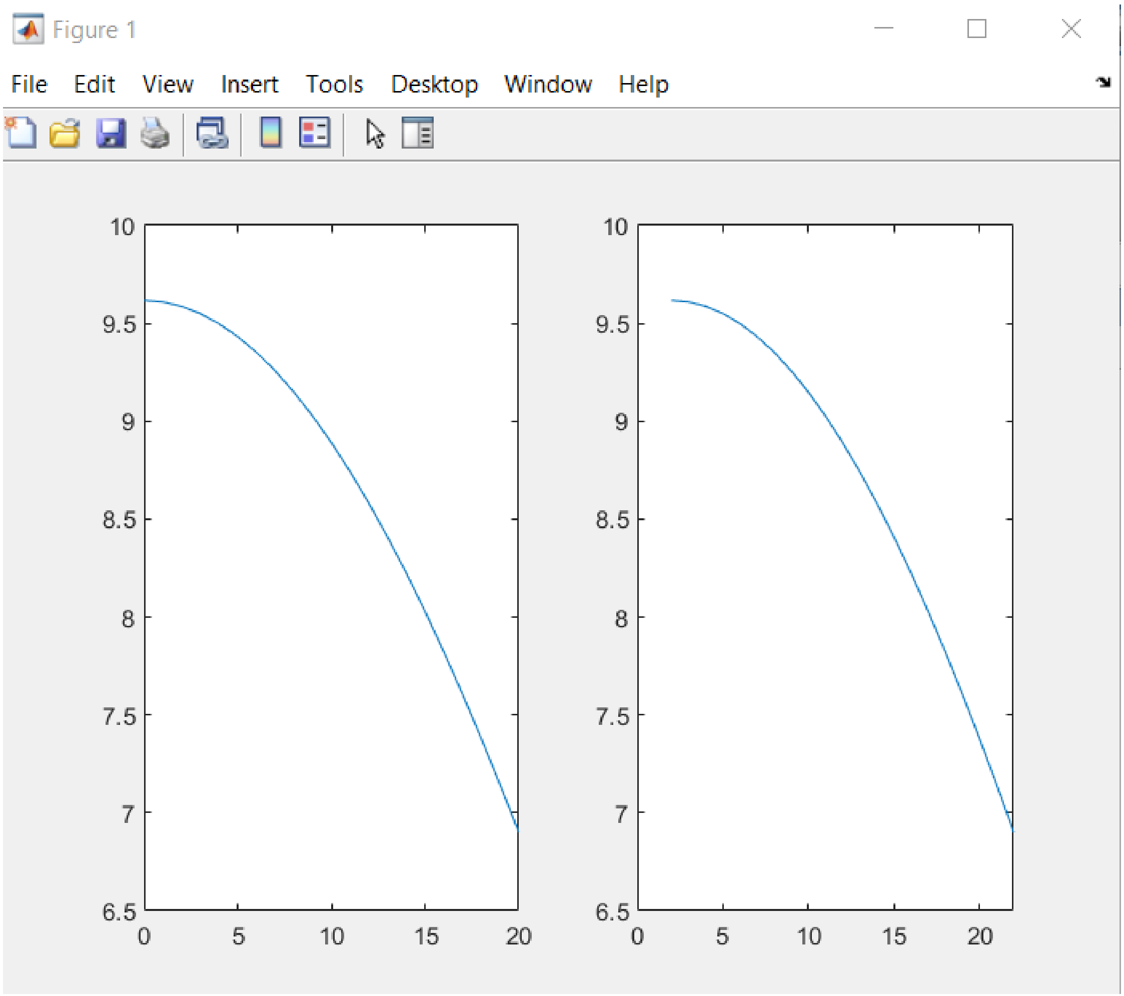


Figure 1
File Edit View Insert Tools Desktop Window Help
10
9.5
9
8.5
8
7.5
7
6.5
0 5 10 15 20
10
9.5
9
8.5
8
7.5
7
6.5
0 5 10 15 20