Sampling of a Sinusoidal Signal and *Reconstruction of Analog Signal*

```
Clf;
t=0:0.0005:1;
F=13;
Ya= cos(2*pi*f*t);
Subplot(2,1,1);
Plot(T,Ya); grid;
Xlabel(' time, msec');
Ylabel('Amplitude');
Axis([0 1 –1.2 1.2]);
Subplot(2,1,2);
T=0.1; f=13;
N=(0:T:1);
Ys= cos(2*pi*f*n);
T=linspace(-0.5,1.5,500);
Tya=sinc((1/T)*t(:,ones(size(n))) – (1/T)*n(:,ones(size(t))))*Ys;
Plot(n,Ys,'o',t,Tya); grid;
Xlabel('Time, msec'); ylabel('Amplitude');
Axis([0 1 –1.2 1.2]);
```

Z Transform of a Discrete Time Function

$X(n) = [1/16^n]u(n)$

Matlab Code

```
syms z n
a=ztrans(1/16^n)
a =
16*z/(16*z-1)
```

Inverse Z-Transform

$X(n) = Z^{-1}[X(Z)]$

$X(Z) = 3*Z / (Z+1)$

Matlab Code

```
syms Z n
iztrans(3*Z/(Z+1))
ans =
3*(-1)^n
```

Pole Zero Diagramfor a Function in Z Domain

Z plane command computes and display the pole-zero diagram of Z function.

The Command is

Zplane(b,a)

To display the pole value, use **root(a)**

To display the zero value, use **root(b)**

$X(Z) = [Z^{-2} + Z^{-1}] / [1-2Z^{-1}+3Z^{-2}]$

Matlab Code

```
b=[0 1 1 ]
a= [1 -2 +3]
```

```
roots(a)
roots(b)
zplane(b,a);
ans =
1.0000 + 1.4142i
1.0000 - 1.4142i
ans =
-1
```

EXC: Use the MATLAB command "roots" to determine the poles and zeros of the following systems-

1) $H(s)=\frac{s^2+2}{S^3+2S^2-S+1}$

Program :

```
clc
clear
z=roots([1,0,2])
p=roots([1,2,-1,1])
```

Output :

```
z =

0 + 1.4142i

        0 - 1.4142i

p =

-2.5468

0.2734 + 0.5638i

     0.2734- 0.5638i
```

2) $H(s)=\frac{S^3+1}{S^4+2S^2+1}$

Program :

```
clc
```

```
clear
z=roots([1,0,0,1])
p=roots([1,0,2,0,1])
```

Output :

```
z =

-1.0000

   0.5000 + 0.8660i

   0.5000 - 0.8660i

p =

-0.0000 + 1.0000i

  -0.0000 - 1.0000i

   0.0000 + 1.0000i

   0.0000 - 1.0000i
```

3) $H(s) = \dfrac{4S^2+8S+10}{2S^3+8S^2+18S+20}$

Program :

```
clc
clear
z=roots([4,8,10])
p=roots([2,8,18,20])
```

Output :

z =

-1.0000 + 1.2247i

-1.0000 - 1.2247i

p =

-1.0000 + 2.0000i

-1.0000 - 2.0000i

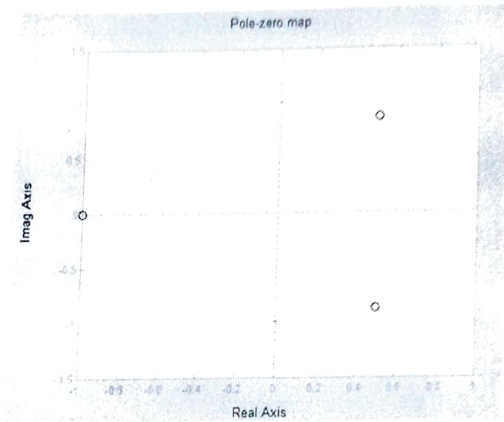
-2.0000

EXC: Use the MATLAB command "pzmap" to plot the poles and zeros of the following systems-

1) $H(s) = \frac{S^3+1}{S^4+2S^2+1}$

Program :

```
clc
clear
num=[1,0,0,1];
den=[1,0,2,0,1];
systf=tf(num,den)
pzmap(systf)
```



Frequency Response

The Freqz function computes and display the frequency response of given Z- Transform of the function
freqz(b,a,npt,Fs)
b= Coeff. Of Numerator
a= Coeff. Of Denominator
Fs= Sampling Frequency
Npt= no. of free points between and Fs/2
$X(Z) = [2+ 5Z_{-1}+9Z_{-2}+5Z_{-3}+3Z_{-4}]/ [5+ 45Z_{-1}+2Z_{-2}+Z_{-3}+Z_{-4}]$

Matlab Code

```
b=[2 5 9 5 3]
a= [5 45 2 1 1]
freqz(b,a);
```

Determine the discrete-time Fourier transform of the following finite-duration sequence:

$$x(n) = \{1, \underset{\uparrow}{2}, 3, 4, 5\}$$

at 501 equispaced frequencies between $[0, \pi]$.

$$X(e^{j\omega}) = \sum_{-\infty}^{\infty} x(n)e^{-j\omega n} = e^{j\omega} + 2 + 3e^{-j\omega} + 4e^{-j2\omega} + 5e^{-j3\omega}$$

```
>> n = -1:3; x = 1:5;  k = 0:500; w = (pi/500)*k;
>> X = x * (exp(-j*pi/500)) .^ (n'*k);
>> magX = abs(X); angX = angle(X);
>> realX = real(X); imagX = imag(X);
>> subplot(2,2,1); plot(k/500,magX);grid
>> xlabel('frequency in pi units'); title('Magnitude Part')
>> subplot(2,2,3); plot(k/500,angX/pi);grid
>> xlabel('frequency in pi units'); title('Angle Part')
>> subplot(2,2,2); plot(k/500,realX);grid
>> xlabel('frequency in pi units'); title('Real Part')
>> subplot(2,2,4); plot(k/500,imagX);grid
>> xlabel('frequency in pi units'); title('Imaginary Part')
```

Determine the frequency response $H(e^{j\omega})$ of a system characterized by $h(n) = (0.9)^n u(n)$. Plot the magnitude and the phase responses.

$$H(e^{j\omega}) = \sum_{-\infty}^{\infty} h(n)e^{-j\omega n} = \sum_{0}^{\infty} (0.9)^n e^{-j\omega n}$$

$$= \sum_{0}^{\infty} (0.9e^{-j\omega})^n = \frac{1}{1 - 0.9e^{-j\omega}}$$

Hence

$$|H(e^{j\omega})| = \sqrt{\frac{1}{(1 - 0.9\cos\omega)^2 + (0.9\sin\omega)^2}} = \frac{1}{\sqrt{1.81 - 1.8\cos\omega}}$$

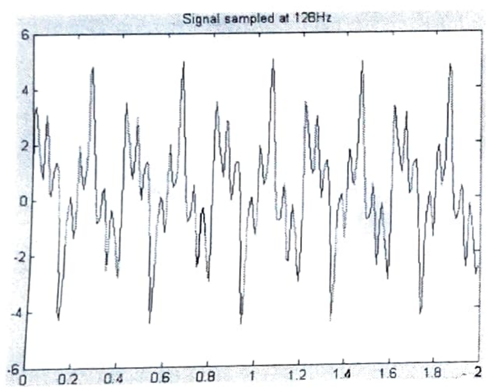
and

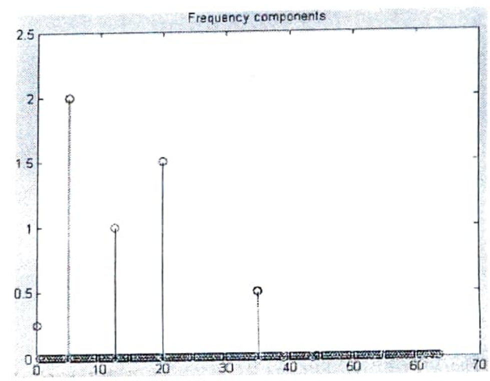
$$\angle H(e^{j\omega}) = -\arctan\left[\frac{0.9\sin\omega}{1 - 0.9\cos\omega}\right]$$

Find the spectrum of the following signal:

$f=0.25+2\sin(2\pi 5k)+\sin(2\pi 12.5k)+1.5\sin(2\pi 20k)+0.5\sin(2\pi 35k)$

```
>> N=256; % number of samples
>> T=1/128; % sampling frequency=128Hz
>> k=0:N-1; time=k*T;
>> f=0.25+2*sin(2*pi*5*k*T)+1*sin(2*pi*12.5*k*T)+...
       +1.5*sin(2*pi*20*k*T)+0.5*sin(2*pi*35*k*T);
>> plot(time,f); title('Signal sampled at 128Hz');
>> F=fft(f);
>> magF=abs([F(1)/N,F(2:N/2)/(N/2)]);
>> hertz=k(1:N/2)*(1/(N*T));
>> stem(hertz,magF), title('Frequency components');
```





ATLAB