A lowpass digital filter's specifications are given by: s = 0.4 , = 0.25 , = 50 , = 0.25

```
% Digital Filter Specifications:
wp = 0.25*pi; % digital Passband freq
ws = 0.4*pi; % digital Stopband freq
Ap = 0.25; % Passband ripple in dB
As = 50; % Stopband attenuation in dB

Td = 1;
```

a. Using an impulse invariance approach, find H(z) that satisfies the above specifications with monotonic passband and stopband.

Design the analog lowpass filter Hc(s).

```
[N,Omegac] = buttord(wp,ws,Ap,As,'s')
```

```
N = 16
Omegac = 0.8769
```

```
[C,D] = butter(N,Omegac,'s')
```

```
C = 1×17
         0         0         0         0         0         0         0         0 ⋯
D = 1×17
    1.0000    8.9466   40.0208  118.5757  260.0165  446.8788  622.0719  714.9710 ⋯
```

We obtain the desired digital filter H(z) = B(z)/A(z) using the coefficients in the arrays B and A.

```
[B,A] = impinvar(C,D,1/Td)
```

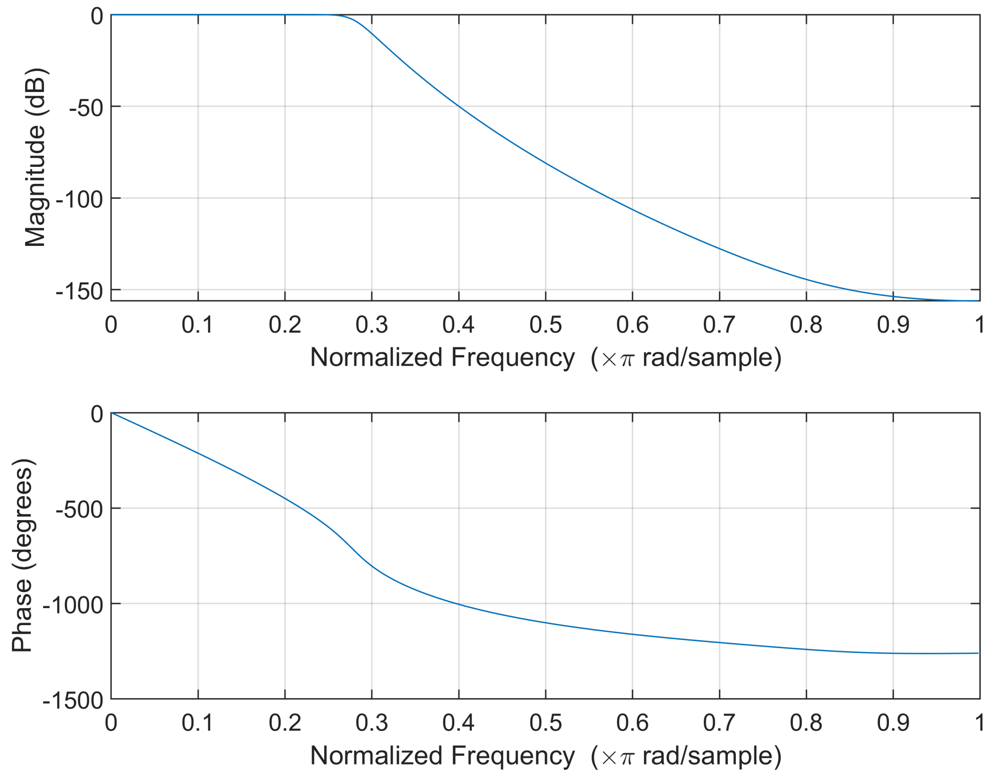
```
Warning: The output is not correct/robust. Coeffs of B(s)/A(s) are real, but B(z)/A(z) has complex coeffs.
 Probable cause is rooting of high-order repeated poles in A(s).
B = 1×17
```

10^{-3} ×

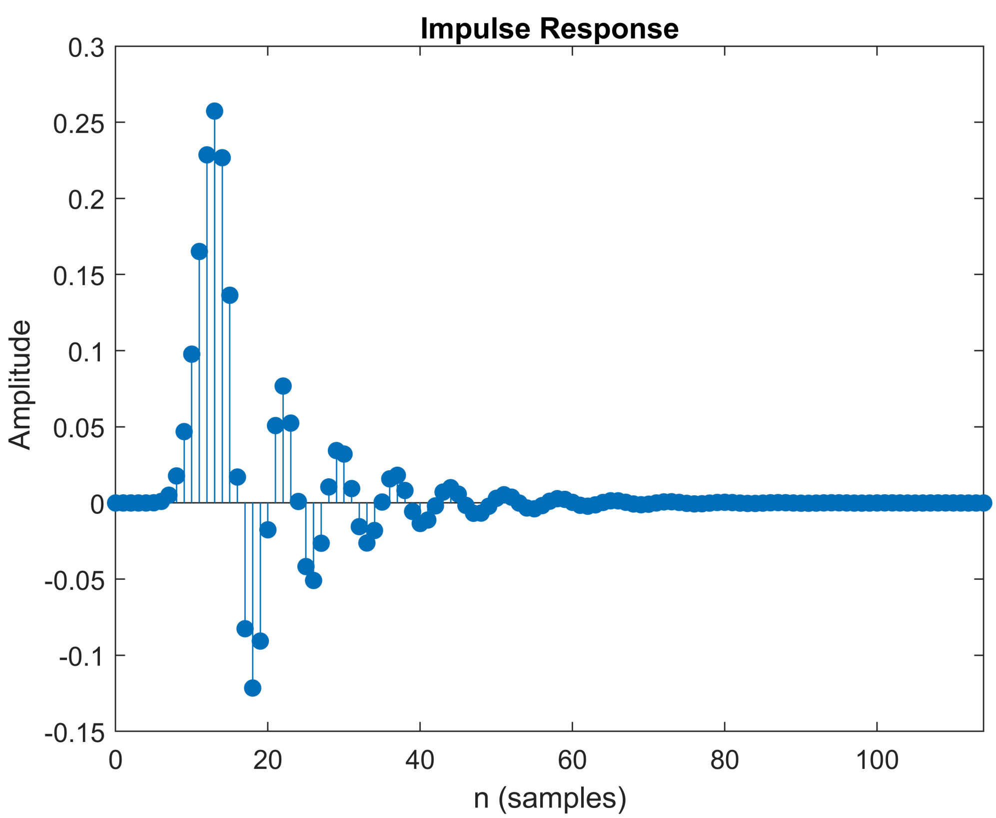
```
   -0.0000    0.0001   -0.0004    0.0011    0.0059    0.0743    0.2731    0.4704 ⋯
A = 1×17
    1.0000   -7.4315   27.1507  -64.1755  109.2091 -141.2721  143.2320 -115.7981 ⋯
```

b. Provide design plots in the form of log-magnitude, phase, group-delay, and impulse responses.

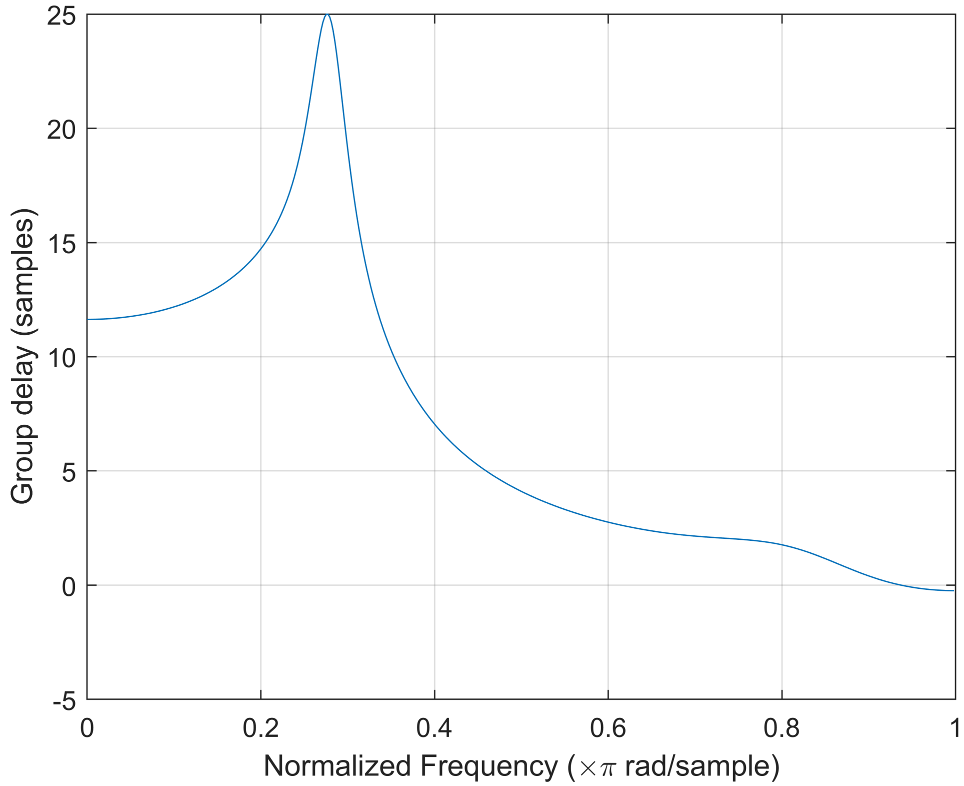
```
freqz(B,A)
```


Magnitude (dB)
Normalized Frequency (×π rad/sample)
Phase (degrees)
Normalized Frequency (×π rad/sample)

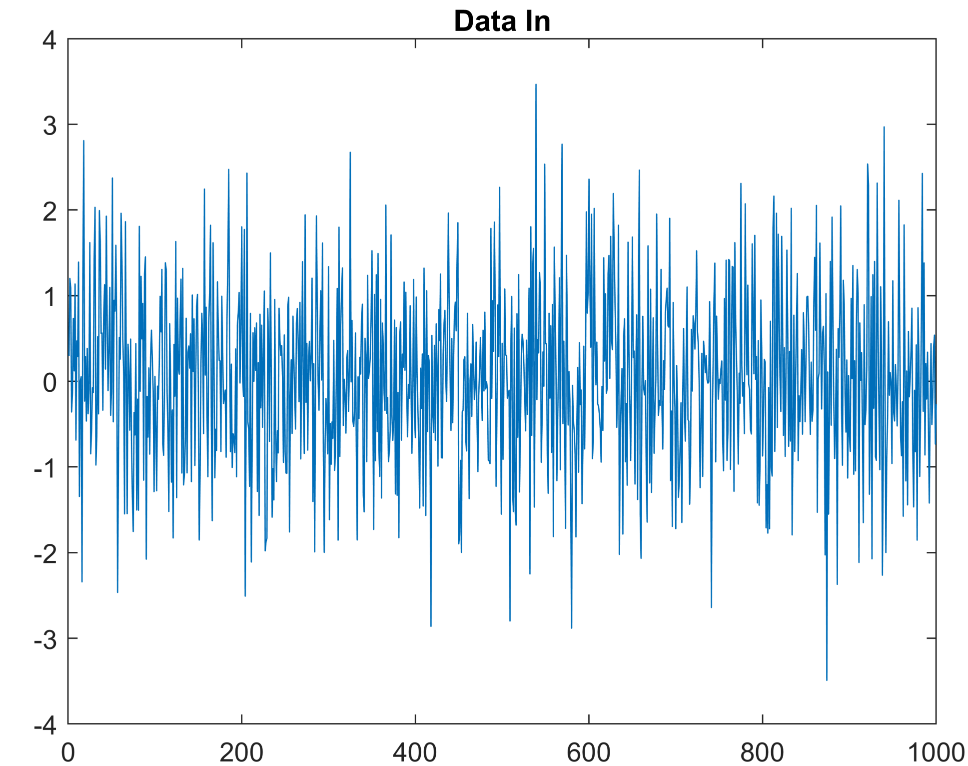
```
impz(B,A)
```


Impulse Response
Amplitude
n (samples)

```
grpdelay(B,A)
```




```
dataIn = randn(1000,1);
dataOut = filter(B,A,dataIn);
plot(dataIn)
title('Data In')
```




```
plot(dataOut)
title("Filtered Data")
```