A lowpass digital filter's specifications are given by:

= 0.65 , = 0.45 , = 60 , = 0.25

```
% Digital Filter Specifications:
wp = 0.45; % digital Passband Normalized freq
ws = 0.65; % digital Stopband Normalized freq
Ap = 0.25; % Passband ripple in dB
As = 60; % Stopband attenuation in dB
```

a. Using bilinear transformation and the Chebyshev I approximation approach obtain a system function H(z) in the cascade form that satisfies the above specifications.

```
[N,omegac] = cheb1ord(wp,ws,Ap,As)
```

```
N = 8
omegac = 0.4500
```

```
[C,D] = cheby1(N,Ap,omegac)
```

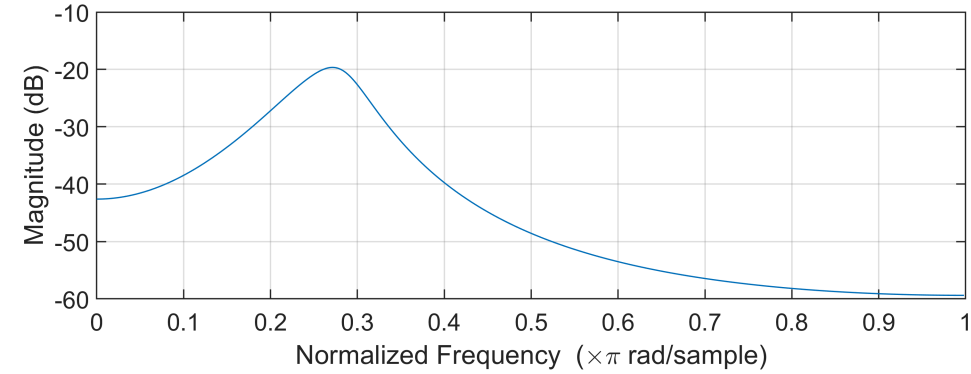
```
C = 1×9
    0.0011    0.0086    0.0300    0.0601    0.0751    0.0601    0.0300    0.0086 ···
D = 1×9
    1.0000   -2.8299    5.3214   -6.7905    6.4563   -4.5523    2.3297   -0.7968 ···
```

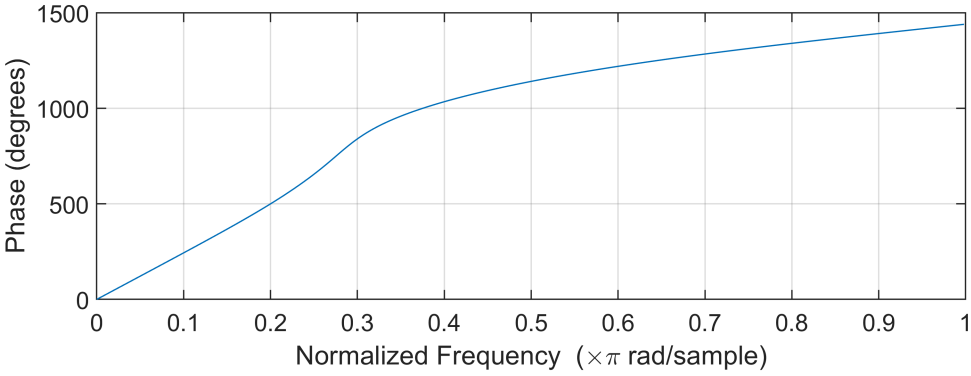
```
[B,A] = bilinear(C,D,1)
```

```
B = 1×9
    0.0767   -0.2045    0.2385   -0.1590    0.0663   -0.0177    0.0029   -0.0003 ···
A = 1×9
    1.0000   -9.2191   38.9157  -98.4707  163.9609 -184.8270  138.8337  -64.2442 ···
```

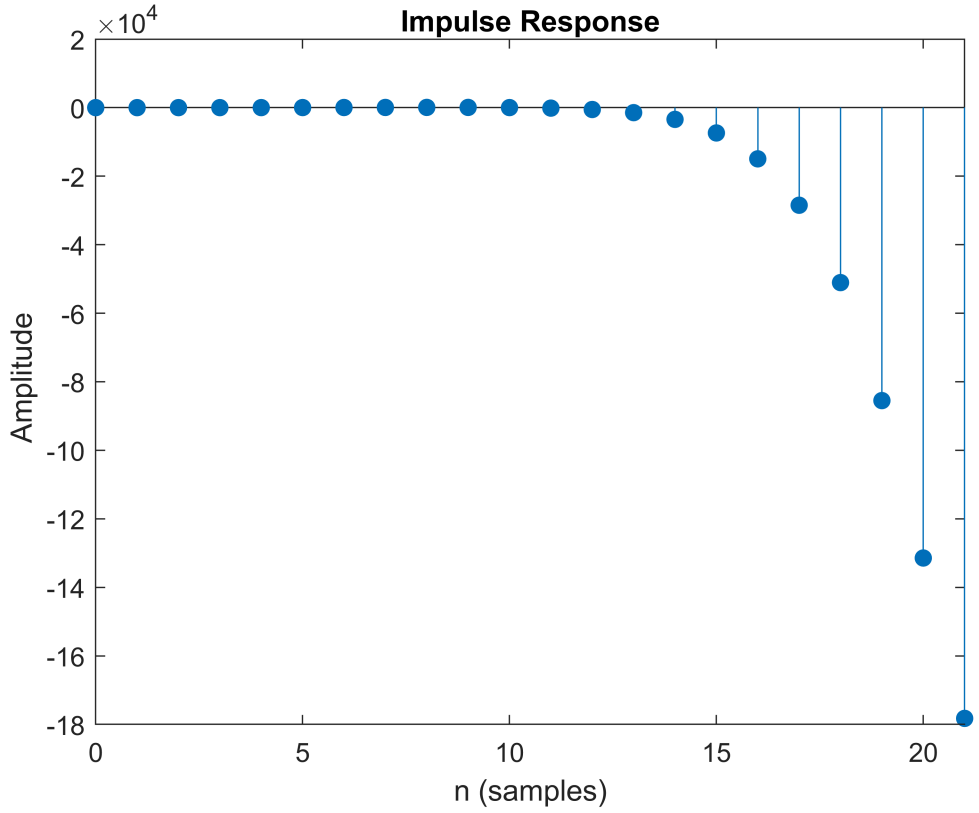
b. Provide design plots in the form of log-magnitude, phase, group-delay, and impulse responses.

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

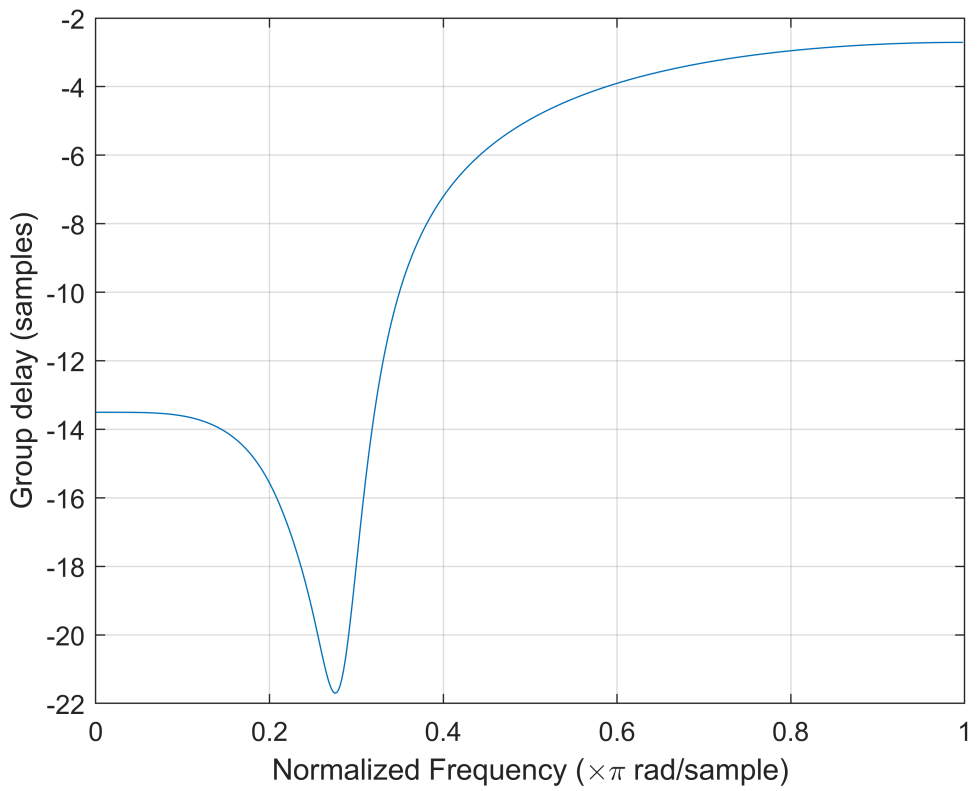

Magnitude (dB)
-10
-20
-30
-40
-50
-60
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Frequency (×π rad/sample)


Phase (degrees)
1500
1000
500
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Frequency (×π rad/sample)

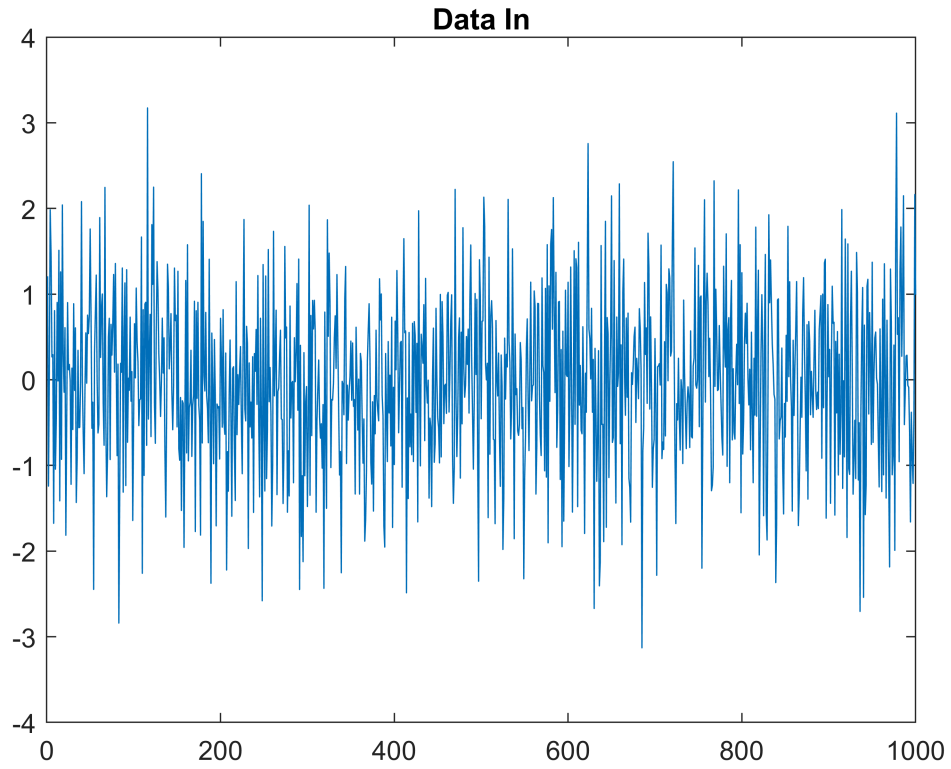
```
impz(B,A)
```


Impulse Response
×10^4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
Amplitude
0
5
10
15
20
n (samples)

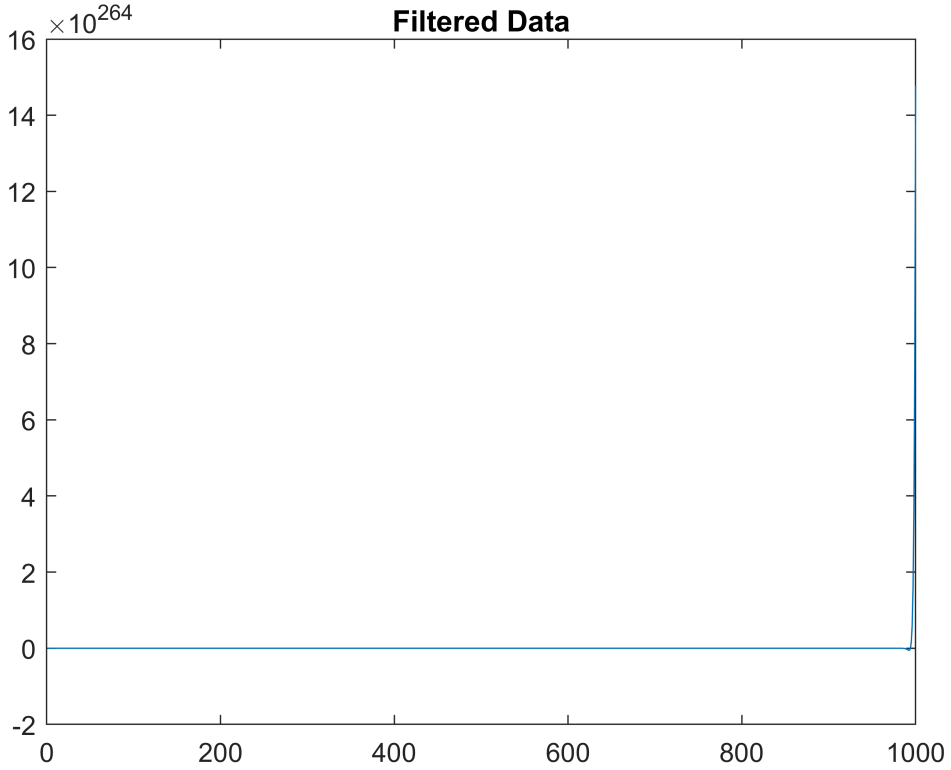
```
grpdelay(B,A)
```




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

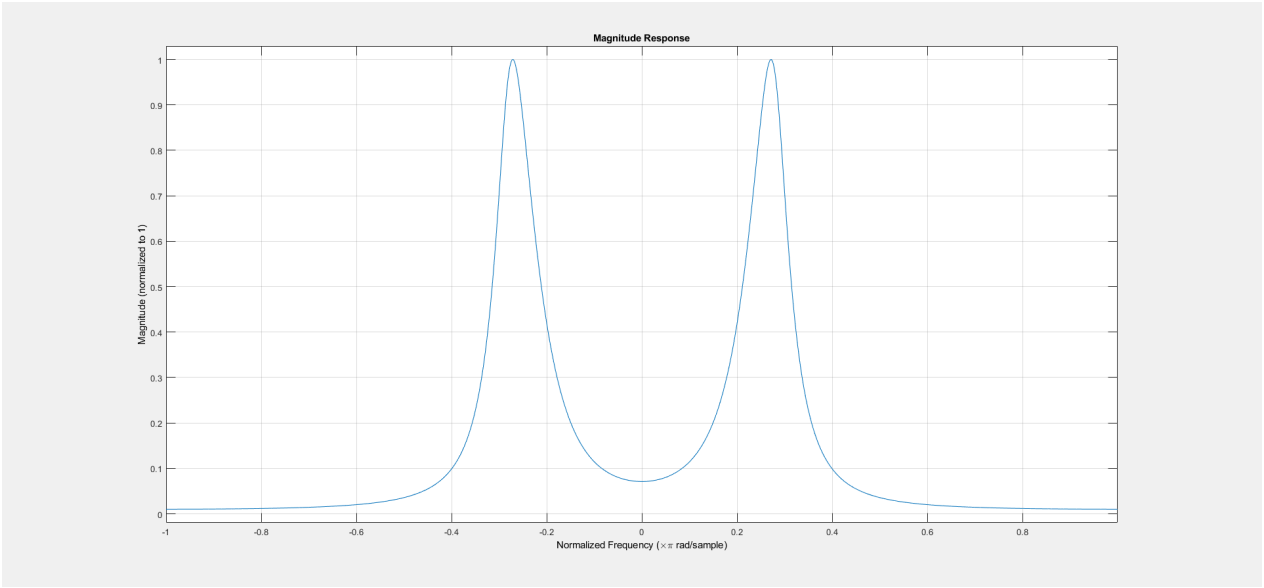



```
plot(dataOut)
title("Filtered Data")
```



c. Determine the exact band-edge frequencies for the given attenuation.

```
fvtool(B,A,'magnitude')
```




```
load('q8_3_c.mat')
cursor_info2
```

```
cursor_info2 = 1×2 struct
```

Fields	Target	Position	DataIndex
1	1×1 Line	[0.3005,...	2463
2	1×1 Line	[0.2332,...	1911

From Graph we can see the band edges are at 0.3pi and 0.23pi