LAB-10

AIM: The aim of this experiment is to design and implement Infinite Impulse Response (IIR) filter of Chebyshev Type I. The filter will be designed to meet specific passband and stopband frequency requirements with defined ripple levels.

The experiment aims to understand the design process and analyze the frequency response characteristics of each type of filter.

THEORY: IIR filters are a type of digital filter with feedback. They are characterized by recursive coefficients in addition to the feedforward coefficients.

Chebyshev Type Filter provides steeper roll-off compared to Butterworth filters but with ripples in the passband. Chebyshev filters are useful when it's acceptable to have ripples in the passband in exchange for sharper roll-off.

The design of each filter type involves specifying parameters such as passband frequency, stopband frequency, passband ripple, and stopband ripple. These parameters are then used to calculate the filter coefficients.

Algorithm:

1. **Input Parameters**:
    - Passband frequency (fp)
    - Stopband frequency (fs)
    - Passband ripple frequency (rp)
    - Stopband ripple frequency (rs)
    - Sampling frequency (f)
2. **Preprocessing**:
    - Convert passband and stopband frequencies to digital frequencies (wp, ws) using the sampling frequency.
    - Calculate the filter order (n) and cutoff frequency (wc) using the chosen filter design function (e.g., cheb1ord, cheby1).
3. **Design Filters**:
    - For each filter type:
        - Design the filter using appropriate design function (e.g., cheby1 for Chebyshev Type I filter).
        - Obtain numerator and denominator coefficients (b, a) of the filter.

4. **Filter Analysis**:

   - For each filter type:
     - Plot the magnitude and frequency response of the filter.
     - Calculate and plot the frequency response characteristics (magnitude and phase) using the freqz function.
     - Display the numerator and denominator coefficients for reference.

5. **Output**:

   - Display the designed filters' characteristics including magnitude response, phase response, and filter coefficients.

CODE:

```
#EXPERIMENT - 10
%Design and implement of IIR filters --- three types 1-
butterworth filter 2- chebychev filter 3- ellipter filter
clc;
clear all;
close all;
pkg load signal;

fp = input('Enter the passband frequency :');
fs = input('Enter the stopband frequency :');
rp = input('Enter the pass band ripple frequency :');
rs = input('Enter the stop band ripple frequency :');
f = input('Enter the sampling frequency :');

wp = 2*fp/f;
ws = 2*fs/f;

[n,wc] = cheb1ord(wp,ws,rp,rs);
[b,a] = cheby1(n,rp,wp);
disp('Numerator coefficients');b
disp('denominator coefficients');a

%Low Pass Filter

[b,a] = cheby1(n,rp,wc,'low');
```

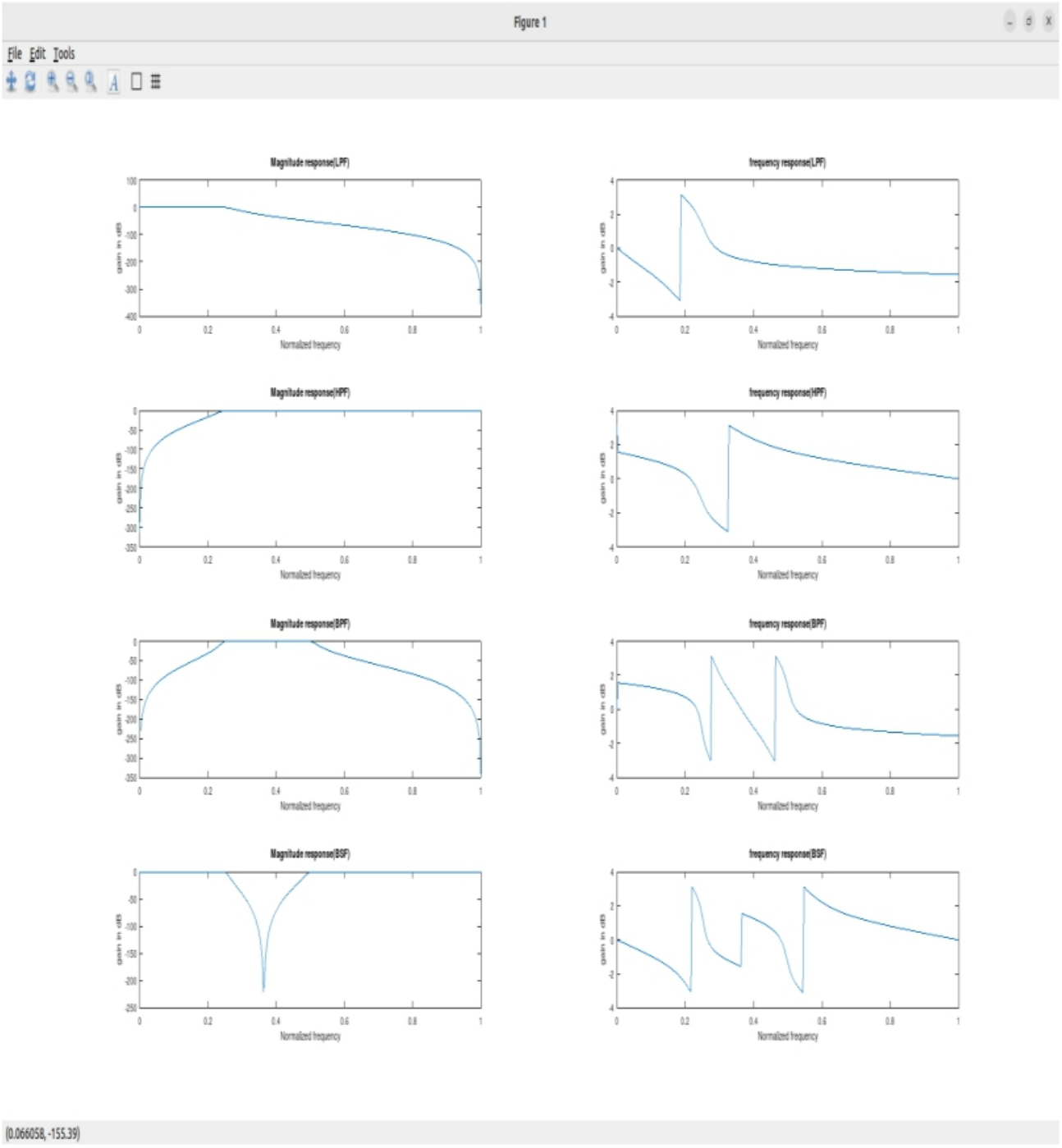
```
w =0:0.01:pi;
[h,om]= freqz(b,a,w);
m = 20*log10(abs(h));
an = angle(h);

subplot(4,2,1);
plot(om/pi,m);
xlabel('Normalized frequency');
ylabel('gain in dB');
title('Magnitude response(LPF)');
zoom(1);

subplot(4,2,2);
plot(om/pi,an);
xlabel('Normalized frequency');
ylabel('gain in dB');
title('frequency response(LPF)');
zoom(1);

%High Pass Filter

[b,a] = cheby1(n,rp,wc,'high');

disp('Numerator coefficients');b
disp('denominator coefficients');a

w = 0:0.01:pi;
[h,om] = freqz(b,a,w);
m = 20*log10(abs(h));
an = angle(h);

subplot(4,2,3);
plot(om/pi,m);
xlabel('Normalized frequency');
ylabel('gain in dB');
title('Magnitude response(HPF)');
zoom(1);

subplot(4,2,4);
plot(om/pi,an);
xlabel('Normalized frequency');
ylabel('gain in dB');
title('frequency response(HPF)');
```

```
zoom(1);

%Band Pass Filter
wn = [wp,ws];
[b,a] = cheby1(n,rp,wn,'pass');
w = 0:0.01:pi;
[h,om] = freqz(b,a,w);
m = 20*log10(abs(h));
an = angle(h);

subplot(4,2,5);
plot(om/pi,m);
xlabel('Normalized frequency');
ylabel('gain in dB');
title('Magnitude response(BPF)');
zoom(1);

subplot(4,2,6);
plot(om/pi,an);
xlabel('Normalized frequency');
ylabel('gain in dB');
title('frequency response(BPF)');
zoom(1);

%Band Stop Filter
wn = [wp,ws];
[b,a] = cheby1(n,rp,wn,'stop');
w = 0:0.01:pi;
[h,om] = freqz(b,a,w);
m = 20*log10(abs(h));
an = angle(h);

subplot(4,2,7);
plot(om/pi,m);
xlabel('Normalized frequency');
ylabel('gain in dB');
title('Magnitude response(BSF)');
zoom(1);

subplot(4,2,8);
plot(om/pi,an);
xlabel('Normalized frequency');
ylabel('gain in dB');
title('frequency response(BSF)');
zoom(1);
```

OUTPUT:

Output of the provided Octave code for the following parameters:

- Passband frequency (fp): 1000 Hz
- Stopband frequency (fs): 2000 Hz
- Passband ripple (rp): 0.5 dB
- Stopband ripple (rs): 40 dB
- Sampling frequency (f): 8000 Hz



CONCLUSION:

The experiment focused on the design and implementation of Chebyshev Type I Infinite Impulse Response (IIR) filters. The analysis revealed that Chebyshev filters provide steeper roll-off compared to Butterworth filters, albeit with ripples in the passband. This experiment deepened the understanding of Chebyshev filter characteristics, aiding in the selection of suitable filters for applications where sharp roll-off is essential, even at the expense of passband ripple.