**EXPERIMENT NO. 6**

**Design and simulation of analog IIR Filters (Butterworth and Chebyshev) Design and simulation of digital IIR Filters (Bilinear transformation) Aim:**

**Equation used for computation:**

**MATLAB Commands used:**

**Code/Program**

**Program 1:**

%generate filter coefficients for the given %order & cutoff Say N=2, fc=150Hz, %fs=1000 Hz, %butterworth filter

[b,a]=butter(2, 150/(1000/2));

%generate simulated input of 100, 300 & 170 Hz, each of 30 points n=1:30;

f1=100;f2=300;f3=170;fs=1000; x=[];

x1=sin(2\*pi\*n\*f1/fs); x2=sin(2\*pi\*n\*f2/fs); x3=sin(2\*pi\*n\*f3/fs); x=[x1 x2 x3]; subplot(2,1,1); stem(x);

title('input');

%generate o/p y=filter(b,a,x);

subplot(2,1,2); stem(y); title('output');

**Computations/Calculations Input:**

**Computation (Clearly mention all steps involved in computation)**

**Output:**

**Graph/Display**

**Program 2:**

% Butterworth filter: Given data: rp=1, rs=40, w1=800, w2=1200,ws=3600;

% Analog frequency aw1=2\*pi\*w1/ws; aw2=2\*pi\*w2/ws;

% Prewrapped frequency pw1 = 2\*tan(aw1/2);

pw2 = 2\*tan(aw2/2);

%Calculate order and cutoff freq [n,wc]= buttord (pw1,pw2,rp,rs,'s');

% analog filter transfer [b,a] = butter(n,wc,'s');

% obtaining the digital filter using bilinear transformation fs=1;

[num,den]= bilinear(b,a,fs);

%plot the frequency response [mag,freq1]=freqz(num,den,128); freq=freq1\*ws/(2\*pi);

m = 20\*log10(abs(mag)); plot(freq,m);

grid;;

**Computations/Calculations Input:**

**Computation (Clearly mention all steps involved in computation)**

**Output:**

**Graph/DisplaY**

**Program 3:**

**To design a chebyshev filter for given specifications**

%Given data rp=1,rs=40,w1=800,w2=1200,ws=3600

%Analog frequencies aw1= 2\*pi\*w1/ws; aw2=2\*pi\*w2/ws;

% Prewrapped frequency assuming T=1/fs pw1 = 2\*tan(aw1/2);

pw2 = 2\*tan(aw2/2);

[n,wc]= cheb1ord (pw1,pw2,rp,rs,'s');

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

% obtaining the digital filter using bilinear transformation fs=1;

[num,den]= bilinear(b,a,fs);

%plot the frequency response [mag,freq1]=freqz(num,den,128); freq=freq1\*ws/(2\*pi);

m = 20\*log10(abs(mag)); plot(freq,m);

grid;

**Computations/Calculations Input:**

**Computation (Clearly mention all steps involved in computation)**

**Output:**

**Graph/Display**

**Inference:**

**EXPERIMENT NO. 7**

**Design and simulation of FIR Filters (LP, HP, BP, BS) by using window techniques Aim:**

**Equation used for computation:**

**MATLAB Commands used:**

**Code/Program**

**%Design and implementation of FIR filter Method 1**

%generate filter coefficients for the given %order & cutoff Say N=33, fc=150Hz, %fs=1000 Hz,

Hamming window

h=fir1(33, 150/(1000/2),hamming(34));

%generate simulated input of 50, 300 & 200 Hz, each of 30 points n=1:30;

f1=50;f2=300;f3=200;fs=1000; x=[];

x1=sin(2\*pi\*n\*f1/fs); x2=sin(2\*pi\*n\*f2/fs); x3=sin(2\*pi\*n\*f3/fs); x=[x1 x2 x3]; subplot(2,1,1); stem(x);

title('input');

%generate o/p

%y=conv(h,x);

y=filter(h,1,x);

subplot(2,1,2); stem(y); title('output');

**Computations/Calculations Input:**

**Computation (Clearly mention all steps involved in computation)**

**Output:**

**Graph/Display**

**%Design and implementation of FIR filter Method 2**

%Method 2: the following program gives only the design of the FIR filter- for implementation continue with the next program (after h[n])

%input data to be given: Passband & Stopband frequency

% Data given: Passband ripple & stopband attenuation As. If As>40 dB, Choose hamming clear

wpa=input('Enter passband edge frequency in Hz'); wsa= input('Enter stopband edge frequency in Hz'); ws1= input('Enter sampling frequency in Hz');

%Calculate transmission BW,Transition band tb,order of the filter wpd=2\*pi\*wpa/ws1;

wsd=2\*pi\*wsa/ws1; tb=wsd-wpd; N=ceil(6.6\*pi/tb)

wc=(wsd+wpd)/2;

%compute the normalized cut off frequency wc=wc/pi;

%calculate & plot the window hw=hamming(N+1); stem(hw);

title('Fir filter window sequence- hamming window');

%find h(n) using FIR h=fir1(N,wc,hamming(N+1));

%plot the frequency response figure(2); [m,w]=freqz(h,1,128); mag=20\*log10(abs(m)); plot(ws1\*w/(2\*pi),mag);

title('Fir filter frequency response'); grid;

**Computations/Calculations Input:**

**Computation (Clearly mention all steps involved in computation)**

**Output:**

**Graph/Display**

**Inference:**