**DIGITAL SIGNAL PROCESSING LAB EXPT.6**

**NIKHIL ROUT**

**22BEC1020**

**AIM:**

**➢ To design a Low Pass Butterworth Filter given the frequency and ripple parameters, plot its magnitude and phase responses and compute its order and cut-off frequency.**

**➢ To design a High Pass Butterworth Filter given the frequency and ripple parameters, plot its magnitude and phase responses and compute its order and cut-off frequency.**

**➢ To design a Band-Pass Butterworth Filter given the normalised frequency and ripple parameters, plot its magnitude and phase responses and compute its order and cut-off frequencies.**

**➢ To design a Band-Stop Butterworth Filter given the normalised frequency and ripple parameters, plot its magnitude and phase responses and compute its order and cut-off frequencies.**

**MATLAB CODE**

clc

clear all

close all

FC\_1=400;

FS\_1=1000;

f\_1=0;

[b\_1,a\_1]=butter(6,FC\_1/(FS\_1/2),'low');

w\_1=0:0.01:pi;

[h\_1,OMEGA\_1]=freqz(b\_1,a\_1,w\_1);

M\_1=20\*log(abs(h\_1));

A\_1=angle(h\_1);

grid on;

subplot(4,2,1);

plot(OMEGA\_1/pi,M\_1,'LineWidth',2);

set(gca,'fontsize',13,'fontweight','bold');

xlabel('Normalized Frequency','fontweight','bold','fontsize',13);

ylabel('Gain(dB)','fontweight','bold','fontsize',13);

title("IIR Filter Magnitude Response (LOW PASS)");

grid on;

subplot(4,2,2);

plot(OMEGA\_1/pi,A\_1,'LineWidth',2);

set(gca,'fontsize',13,'fontweight','bold');

xlabel('Normalized Frequency','fontweight','bold','fontsize',13);

ylabel('Phase angle (Radians)','fontweight','bold','fontsize',13);

title("IIR Filter Phase Response (LOW PASS)");

grid on;

FC\_1=90;

FS\_1=1000;

[b\_1,a\_1]=butter(6,FC\_1/(FS\_1/2),'high');

w\_1=0:0.01:pi;

[h\_1,OMEGA\_1]=freqz(b\_1,a\_1,w\_1);

M\_1=20\*log(abs(h\_1));

A\_1=angle(h\_1);

grid on;

subplot(4,2,3);

plot(OMEGA\_1/pi,M\_1,'LineWidth',2);

set(gca,'fontsize',13,'fontweight','bold');

xlabel('Normalized Frequency','fontweight','bold','fontsize',13);

ylabel('Gain(dB)','fontweight','bold','fontsize',13);

title("IIR Filter Magnitude Response (HIGH PASS)");

grid on;

subplot(4,2,4);

plot(OMEGA\_1/pi,A\_1,'LineWidth',2);

set(gca,'fontsize',13,'fontweight','bold');

xlabel('Normalized Frequency','fontweight','bold','fontsize',13);

ylabel('Phase angle (Radians)','fontweight','bold','fontsize',13);

title("IIR Filter Phase Response (HIGH PASS)");

grid on;

FS\_3=3000;

wp\_3=[200 900]/FS\_3;

ws\_3=[100 1100]/FS\_3;

[n\_3,wn\_3]=buttord(wp\_3,ws\_3,0.1,1);

[b\_3,a\_3]=butter(n\_3,wn\_3);

w\_3=0:0.01:pi;

[h\_3,OMEGA\_3]=freqz(b\_3,a\_3,w\_3);

M\_3=20\*log(abs(h\_3));

A\_3=angle(h\_3);

subplot(4,2,5);

plot(OMEGA\_3/pi,M\_3,'LineWidth',2);

set(gca,'fontsize',13,'fontweight','bold');

xlabel('Normalized Frequency','fontweight','bold','fontsize',13);

ylabel('Gain(dB)','fontweight','bold','fontsize',13);

title("IIR Filter Magnitude Response (BAND PASS)");

grid on;

subplot(4,2,6);

plot(OMEGA\_3/pi,A\_3,'LineWidth',2);

set(gca,'fontsize',13,'fontweight','bold');

xlabel('Normalized Frequency','fontweight','bold','fontsize',13);

ylabel('Phase angle (Radians)','fontweight','bold','fontsize',13);

title("IIR Filter Phase Response (BAND PASS)");

grid on;

FS\_4=3000;

n\_4=[200 900]/FS\_4;

ws\_4=[100 1100]/FS\_4;

[n\_4,wn\_4]=buttord([0.3,0.7],[0.4,0.6],0.4,50);

[b\_4,a\_4]=butter(n\_4,wn\_4,'stop');

w\_4=0:0.01:pi;

[h\_4,OMEGA\_4]=freqz(b\_4,a\_4,w\_4);

M\_4=20\*log(abs(h\_4));

A\_4=angle(h\_4);

subplot(4,2,7);

plot(OMEGA\_4/pi,M\_4,'LineWidth',2);

set(gca,'fontsize',13,'fontweight','bold');

xlabel('Normalized Frequency','fontweight','bold','fontsize',13);

ylabel('Gain(dB)','fontweight','bold','fontsize',13);

title("IIR Filter Magnitude Response (STOP BAND)");

grid on;

subplot(4,2,8);

plot(OMEGA\_4/pi,A\_4,'LineWidth',2);

set(gca,'fontsize',13,'fontweight','bold');

xlabel('Normalized Frequency','fontweight','bold','fontsize',13);

ylabel('Phase angle (Radians)','fontweight','bold','fontsize',13);

title("IIR Filter Phase Response (STOP BAND)");

grid on;



