Digital Signal Processing [Lab-10]

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Objective:

Design of IIR filter (In this lab, we found the freqency response of various kinds of IIR filters such as LFP and HPF o and Bandpass filter and Bandstp filters)

Program:

```
% * |*Matlab Commands for First-order Low pass IIR digital filter *|

wc=pi/4;
alpha=(1-sin(wc) )/(cos(wc));

diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    H_lp(i)=((1-alpha)/2)* ( 1+exp(-1*1j*w) )/(1-(alpha*exp(-1*1j*w)) );
end
H_lp_abs=abs(H_lp);
H_lp_phase=phase(H_lp);
H_lp_max=max(H_lp_abs);
H_lp_3db=H_lp_max/sqrt(2);
```

```
• *Matlab Commands for First-order Low pass filter for alpha=0.5 *

alpha=0.5;

diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    H_lp_point5(i)=((1-alpha)/2)* ( 1+exp(-1*1j*w) )/(1-(alpha*exp(-1*1j*w)) );
end
H_lp_abs_point5=abs(H_lp_point5);
H_lp_phase_point5=phase(H_lp_point5);
H_lp__point5_max=max(H_lp_abs_point5);
level=H_lp__point5_max/sqrt(2);
```

```
count=1;
level1=level+0.05;
level2=level-0.05;
for i=1:61
    if level1>H_lp_abs_point5(i) && level2<H_lp_abs_point5(i)
        H_lp_point5_3db(count)=H_lp_abs_point5(i);
        H_lp_point5_index(count)=i;
        count=count+1;
    end
end
```

• *Matlab Commands for First-order Low pass filter for alpha=0.7 *

```
alpha=0.7;
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    H_lp_point7(i)=((1-alpha)/2)* ( 1+exp(-1*1j*w) )/(1-(alpha*exp(-1*1j*w)) );
end
H_lp_abs_point7=abs(H_lp_point7);
H_lp_phase_point7=phase(H_lp_point7);
H_lp_point7_max=max(H_lp_abs_point7);
level=H_lp_point7_max/sqrt(2);

count=1;
level1=level+0.05;
level2=level-0.05;

for i=1:61
    if level1>H_lp_abs_point7(i) && level2<H_lp_abs_point7(i)
        H_lp_point7_3db(count)=H_lp_abs_point7(i);
        H_lp_point7_index(count)=i;
        count=count+1;
    end
end
```

• *Matlab Commands for First-order Low pass filter for alpha=0.8 *

```
alpha=0.8;
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    H_lp_point8(i)=((1-alpha)/2)* ( 1+exp(-1*1j*w) )/(1-(alpha*exp(-1*1j*w)) );
end
H_lp_abs_point8=abs(H_lp_point8);
H_lp_phase_point8=phase(H_lp_point8);
H_lp_point8_max=max(H_lp_abs_point8);
level=H_lp_point8_max/sqrt(2);

level1=level+0.05;
level2=level-0.05;

for i=1:61
    if level1>H_lp_abs_point8(i) && level2<H_lp_abs_point8(i)
        H_lp_point8_3db(count)=H_lp_abs_point8(i);
```

```
        H_lp_point8_index(count)=i;
        count=count+1;
    end
end
```

• *Matlab Commands for First-order High pass IIR digital filter *

```
wc=pi/4;
alpha=(1-sin(wc) )/(cos(wc));

diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    H_hp(i)=((1+alpha)/2)* ( 1- exp(-1*1j*w) )/(1-(alpha*exp(-1*1j*w)) );
end
H_hp_abs=abs(H_hp);
H_hp_phase=phase(H_hp);
H_hp_max=max(H_hp_abs);
H_hp_3db=H_hp_max/sqrt(2);
```

• *Matlab Commands for First-order High pass filter for alpha=0.5 *

```
alpha=0.5;

diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    H_hp_point5(i)=((1+alpha)/2)* ( 1- exp(-1*1j*w) )/(1-(alpha*exp(-1*1j*w)) );
end
H_hp_abs_point5=abs(H_hp_point5);
H_hp_phase_point5=phase(H_hp_point5);
H_hp__point5_max=max(H_hp_abs_point5);
level=H_hp__point5_max/sqrt(2);

count=1;
level1=level+0.05;
level2=level-0.05;
for i=1:61
    if level1>H_hp_abs_point5(i) && level2<H_hp_abs_point5(i)
        H_hp_point5_3db(count)=H_hp_abs_point5(i);
        H_hp_point5_index(count)=i;
        count=count+1;
    end
end
```

• *Matlab Commands for First-order High pass filter for alpha=0.7 *

```
alpha=0.7;
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    H_hp_point7(i)=((1+alpha)/2)* ( 1- exp(-1*1j*w) )/(1-(alpha*exp(-1*1j*w)) );
end
H_hp_abs_point7=abs(H_hp_point7);
H_hp_phase_point7=phase(H_hp_point7);
H_hp_point7_max=max(H_hp_abs_point7);
```

```
level=H_hp_point7_max/sqrt(2);

count=1;
level1=level+0.05;
level2=level-0.05;

for i=1:61
    if level1>H_hp_abs_point7(i) && level2<H_hp_abs_point7(i)
        H_hp_point7_3db(count)=H_hp_abs_point7(i);
        H_hp_point7_index(count)=i;
        count=count+1;
    end
end
```

• *Matlab Commands for First-order High pass filter for alpha=0.8 *

```
alpha=0.8;
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    H_hp_point8(i)=((1+alpha)/2)* ( 1- exp(-1*1j*w) )/(1-(alpha*exp(-1*1j*w)) );
end
H_hp_abs_point8=abs(H_hp_point8);
H_hp_phase_point8=phase(H_hp_point8);
H_hp_point8_max=max(H_hp_abs_point8);
level=H_hp_point8_max/sqrt(2);

level1=level+0.05;
level2=level-0.05;

for i=1:61
    if level1>H_hp_abs_point8(i) && level2<H_hp_abs_point8(i)
        H_hp_point8_3db(count)=H_hp_abs_point8(i);
        H_hp_point8_index(count)=i;
        count=count+1;
    end
end
```

• *Matlab Commands for Second order Band Pass filter *

```
wo=0.4*pi;
bandw_3db=0.1*pi;
beta=cos(wo);
% cos(bandw_3db)=0.9511=(2*alpha)/(1+(alpha^2))
% alpha=1.37 or alpha=0.72
alpha=0.72;

h_bandpass=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandpass(i)=(1/(1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w))));
    h_bandpass(i)=h_bandpass(i)*( 1-exp(-2*1j*w) )*((1-alpha)/2);
end
```

```
h_bandpass_abs=abs(h_bandpass);
h_bandpass_phase=phase(h_bandpass);
level=max(h_bandpass_abs)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;
for i=1:61
    if level1>h_bandpass_abs(i) && level2<h_bandpass_abs(i)
        h_bandpass_3db(count)=h_bandpass_abs(i);
        H_bandpass_index(count)=i;
        count=count+1;
    end
end
h_bandpass_3db_bandwidth=41-20;
Q=wo/(h_bandpass_3db_bandwidth*diff);
```

- *Matlab Commands for 2nd order Band Pass filter for beta=0.5 and alpha=0.2 *

```
beta=0.5;
alpha=0.2;
h_bandpass_a2b5=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandpass_a2b5(i)=(1/(1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) ))
    h_bandpass_a2b5(i)=h_bandpass_a2b5(i)*( 1-exp(-2*1j*w) )*((1-alpha)/2);
end

h_bandpass_abs_a2b5=abs(h_bandpass_a2b5);
h_bandpass_phase_a2b5=phase(h_bandpass_a2b5);
level=max(h_bandpass_abs_a2b5)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;
for i=1:61
    if level1>h_bandpass_abs_a2b5(i) && level2<h_bandpass_abs_a2b5(i)
        h_bandpass_a2b5_3db(count)=h_bandpass_abs_a2b5(i);
        H_bandpass_a2b5_index(count)=i;
        count=count+1;
    end
end
h_bandpass_a2b5_3db_band=(42-19)*diff;
Q_bandpass_a2b5=acos(beta)/h_bandpass_a2b5_3db_band;
```

- *Matlab Commands for 2nd order Band Pass filter for beta=0.5 and alpha=0.5 *

```
beta=0.5;
alpha=0.5;

h_bandpass_a5b5=zeros(1,61);
diff=(2*pi)/61;
```

```
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandpass_a5b5(i)=(1/(1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w))));
    h_bandpass_a5b5(i)=h_bandpass_a5b5(i)*( 1-exp(-2*1j*w) )*((1-alpha)/2);
end

h_bandpass_abs_a5b5=abs(h_bandpass_a5b5);
h_bandpass_phase_a5b5=phase(h_bandpass_a5b5);
level=max(h_bandpass_abs_a5b5)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandpass_abs_a5b5(i) && level2<h_bandpass_abs_a5b5(i)
        h_bandpass_a5b5_3db(count)=h_bandpass_abs_a5b5(i);
        H_bandpass_a5b5_index(count)=i;
        count=count+1;
    end
end
h_bandpass_a5b5_3db_band=(42-19)*diff;
Q_bandpass_a5b5=acos(beta)/h_bandpass_a5b5_3db_band;
```

- *Matlab Commands for 2nd order Band Pass filter for beta=0.5 and alpha=0.8 *

```
beta=0.5;
alpha=0.8;

h_bandpass_a8b5=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandpass_a8b5(i)=(1/(1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w))));
    h_bandpass_a8b5(i)=h_bandpass_a8b5(i)*( 1-exp(-2*1j*w) )*((1-alpha)/2);
end

h_bandpass_abs_a8b5=abs(h_bandpass_a8b5);
h_bandpass_phase_a8b5=phase(h_bandpass_a8b5);
level=max(h_bandpass_abs_a8b5)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandpass_abs_a8b5(i) && level2<h_bandpass_abs_a8b5(i)
        h_bandpass_a8b5_3db(count)=h_bandpass_abs_a8b5(i);
        h_bandpass_a8b5_index(count)=i;
        count=count+1;
    end
end
h_bandpass_a8b5_3db_band=(42-19)*diff;
```

```
Q_bandpass_a8b5=acos(beta)/h_bandpass_a8b5_3db_band;
```

- *Matlab Commands for 2nd order Band Pass filter for beta=0.1 and alpha=0.6 *

```
beta=0.1;
alpha=0.6;

h_bandpass_b1a6=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandpass_b1a6(i)=(1/(1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w))));
    h_bandpass_b1a6(i)=h_bandpass_b1a6(i)*( 1-exp(-2*1j*w) )*((1-alpha)/2);
end

h_bandpass_abs_b1a6=abs(h_bandpass_b1a6);
h_bandpass_phase_b1a6=phase(h_bandpass_b1a6);
level=max(h_bandpass_abs_b1a6)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandpass_abs_b1a6(i) && level2<h_bandpass_abs_b1a6(i)
        h_bandpass_b1a6_3db(count)=h_bandpass_abs_b1a6(i);
        h_bandpass_b1a6_index(count)=i;
        count=count+1;
    end
end
h_bandpass_b1a6_3db_band=(47-14)*diff;
Q_bandpass_b1a6=acos(beta)/h_bandpass_b1a6_3db_band;
```

- *Matlab Commands for 2nd order Band Pass filter for beta=0.5 and alpha=0.6 *

```
beta=0.5;
alpha=0.6;

h_bandpass_b5a6=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandpass_b5a6(i)=(1/(1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w))));
    h_bandpass_b5a6(i)=h_bandpass_b5a6(i)*( 1-exp(-2*1j*w) )*((1-alpha)/2);
end

h_bandpass_abs_b5a6=abs(h_bandpass_b5a6);
h_bandpass_phase_b5a6=phase(h_bandpass_b5a6);
level=max(h_bandpass_abs_b5a6)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;
```

```
for i=1:61
    if level1>h_bandpass_abs_b5a6(i) && level2<h_bandpass_abs_b5a6(i)
        h_bandpass_b5a6_3db(count)=h_bandpass_abs_b5a6(i);
        h_bandpass_b5a6_index(count)=i;
        count=count+1;
    end
end
h_bandpass_b5a6_3db_band=(43-18)*diff;
Q_bandpass_b5a6=acos(beta)/h_bandpass_b5a6_3db_band;
```

• *Matlab Commands for 2nd order Band Pass filter for beta=0.8 and alpha=0.6 *

```
beta=0.8;
alpha=0.5;

h_bandpass_b8a6=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandpass_b8a6(i)=(1/(1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w))));
    h_bandpass_b8a6(i)=h_bandpass_b8a6(i)*( 1-exp(-2*1j*w) )*((1-alpha)/2);
end

h_bandpass_abs_b8a6=abs(h_bandpass_b8a6);
h_bandpass_phase_b8a6=phase(h_bandpass_b8a6);
level=max(h_bandpass_abs_b8a6)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandpass_abs_b8a6(i) && level2<h_bandpass_abs_b8a6(i)
        h_bandpass_b8a6_3db(count)=h_bandpass_abs_b8a6(i);
        h_bandpass_b8a6_index(count)=i;
        count=count+1;
    end
end
h_bandpass_b8a6_3db_band=(40-20)*diff;
Q_bandpass_b8a6=acos(beta)/h_bandpass_b8a6_3db_band;
```

• *Matlab Commands for Second-order Band stop IIR digital filter *

```
wo=0.4*pi;
threedB_bandw=pi*0.1;

beta=acos(wo);
% cos(threedB_bandw)=0.9511=2*alpha/(1+alpha^2)
% alpha=0.72,1.37 so alpha=0.72
alpha=0.72;
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
```

```
    h_bandstop(i)=1/( 1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) );
    h_bandstop(i)=h_bandstop(i)*(1-(2*beta*exp(-1*1j*w))+exp(-2*1j*w));
    h_bandstop(i)= h_bandstop(i)*((1+alpha)/2);
end

h_bandstop_abs=abs(h_bandstop);
h_bandstop_phase=phase(h_bandstop);
level=max(h_bandstop_abs)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandstop_abs(i) && level2<h_bandstop_abs(i)
        h_bandstop_3db(count)=h_bandstop_abs(i);
        h_bandstop_index(count)=i;
        count=count+1;
    end
end

h_bandstop_3db_band=(23-8)*diff;
Q_bandstop=acos(beta)/h_bandstop_3db_band;
```

- *Matlab Commands for 2nd order Band Stop filter for beta=0.5 and alpha=0.2 *

```
beta=0.5;
alpha=0.2;
h_bandstop_a2b5=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandstop_a2b5(i)=1/( 1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) );
    h_bandstop_a2b5(i)=h_bandstop_a2b5(i)*(1-(2*beta*exp(-1*1j*w))+exp(-2*1j*w));
    h_bandstop_a2b5(i)= h_bandstop_a2b5(i)*((1+alpha)/2);
end
h_bandstop_abs_a2b5=abs(h_bandstop_a2b5);
h_bandstop_phase_a2b5=phase(h_bandstop_a2b5);
level=max(h_bandstop_abs_a2b5)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;
for i=1:61
    if level1>h_bandstop_abs_a2b5(i) && level2<h_bandstop_abs_a2b5(i)
        h_bandstop_a2b5_3db(count)=h_bandstop_abs_a2b5(i);
        H_bandstop_a2b5_index(count)=i;
        count=count+1;
    end
end
h_bandstop_a2b5_3db_band=(36-25)*diff;
Q_bandstop_a2b5=acos(beta)/h_bandstop_a2b5_3db_band;

% * |*Matlab Commands for 2nd order Band Stop filter for beta=0.5 and alpha=0.5 *|
```

```
beta=0.5;
alpha=0.5;

h_bandstop_a5b5=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandstop_a5b5(i)=1/( 1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) );
    h_bandstop_a5b5(i)=h_bandstop_a5b5(i)*(1-(2*beta*exp(-1*1j*w))+exp(-2*1j*w));
    h_bandstop_a5b5(i)= h_bandstop_a5b5(i)*((1+alpha)/2);
end

h_bandstop_abs_a5b5=abs(h_bandstop_a5b5);
h_bandstop_phase_a5b5=phase(h_bandstop_a5b5);
level=max(h_bandstop_abs_a5b5)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandstop_abs_a5b5(i) && level2<h_bandstop_abs_a5b5(i)
        h_bandstop_a5b5_3db(count)=h_bandstop_abs_a5b5(i);
        H_bandstop_a5b5_index(count)=i;
        count=count+1;
    end
end

h_bandstop_a5b5_3db_band=(44-17)*diff;
Q_bandstop_a5b5=acos(beta)/h_bandstop_a5b5_3db_band;
```

- *Matlab Commands for 2nd order Band Stop filter for beta=0.5 and alpha=0.8 *

```
beta=0.5;
alpha=0.8;

h_bandstop_a8b5=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandstop_a8b5(i)=1/( 1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) );
    h_bandstop_a8b5(i)=h_bandstop_a8b5(i)*(1-(2*beta*exp(-1*1j*w))+exp(-2*1j*w));
    h_bandstop_a8b5(i)= h_bandstop_a8b5(i)*((1+alpha)/2);
end

h_bandstop_abs_a8b5=abs(h_bandstop_a8b5);
h_bandstop_phase_a8b5=phase(h_bandstop_a8b5);
level=max(h_bandstop_abs_a8b5)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;
```

```
for i=1:61
    if level1>h_bandstop_abs_a8b5(i) && level2<h_bandstop_abs_a8b5(i)
        h_bandstop_a8b5_3db(count)=h_bandstop_abs_a8b5(i);
        h_bandstop_a8b5_index(count)=i;
        count=count+1;
    end
end
h_bandstop_a8b5_3db_band=(42-19)*diff;
Q_bandstop_a8b5=acos(beta)/h_bandstop_a8b5_3db_band;
```

- *Matlab Commands for 2nd order Band Stop filter for beta=0.1 and alpha=0.6 *

```
beta=0.1;
alpha=0.6;

h_bandstop_b1a6=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandstop_b1a6(i)=1/( 1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) );
    h_bandstop_b1a6(i)=h_bandstop_b1a6(i)*(1-(2*beta*exp(-1*1j*w))+exp(-2*1j*w));
    h_bandstop_b1a6(i)= h_bandstop_b1a6(i)*((1+alpha)/2);
end

h_bandstop_abs_b1a6=abs(h_bandstop_b1a6);
h_bandstop_phase_b1a6=phase(h_bandstop_b1a6);
level=max(h_bandstop_abs_b1a6)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandstop_abs_b1a6(i) && level2<h_bandstop_abs_b1a6(i)
        h_bandstop_b1a6_3db(count)=h_bandstop_abs_b1a6(i);
        h_bandstop_b1a6_index(count)=i;
        count=count+1;
    end
end
h_bandstop_b1a6_3db_band=(47-14)*diff;
Q_bandstop_b1a6=acos(beta)/h_bandstop_b1a6_3db_band;
```

- *Matlab Commands for 2nd order Band stop filter for beta=0.5 and alpha=0.6 *

```
beta=0.5;
alpha=0.6;

h_bandstop_b5a6=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandstop_b5a6(i)=1/( 1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) );
```

```
    h_bandstop_b5a6(i)=h_bandstop_b5a6(i)*(1-(2*beta*exp(-1*1j*w))+exp(-2*1j*w));
    h_bandstop_b5a6(i)=h_bandstop_b5a6(i)*((1+alpha)/2);
end

h_bandstop_abs_b5a6=abs(h_bandstop_b5a6);
h_bandstop_phase_b5a6=phase(h_bandstop_b5a6);
level=max(h_bandstop_abs_b5a6)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandstop_abs_b5a6(i) && level2<h_bandstop_abs_b5a6(i)
    h_bandstop_b5a6(i)=1/( 1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) );
    h_bandstop_b5a6(i)=h_bandstop_b5a6(i)*(1-(2*beta*exp(-1*1j*w))+exp(-2*1j*w));
    h_bandstop_b5a6(i)=h_bandstop_b5a6(i)*((1+alpha)/2);
    count=count+1;
    end
end
h_bandstop_b5a6_3db_band=(43-18)*diff;
Q_bandstop_b5a6=acos(beta)/h_bandstop_b5a6_3db_band;
```

- *Matlab Commands for 2nd order Band Stop filter for beta=0.8 and alpha=0.6 *

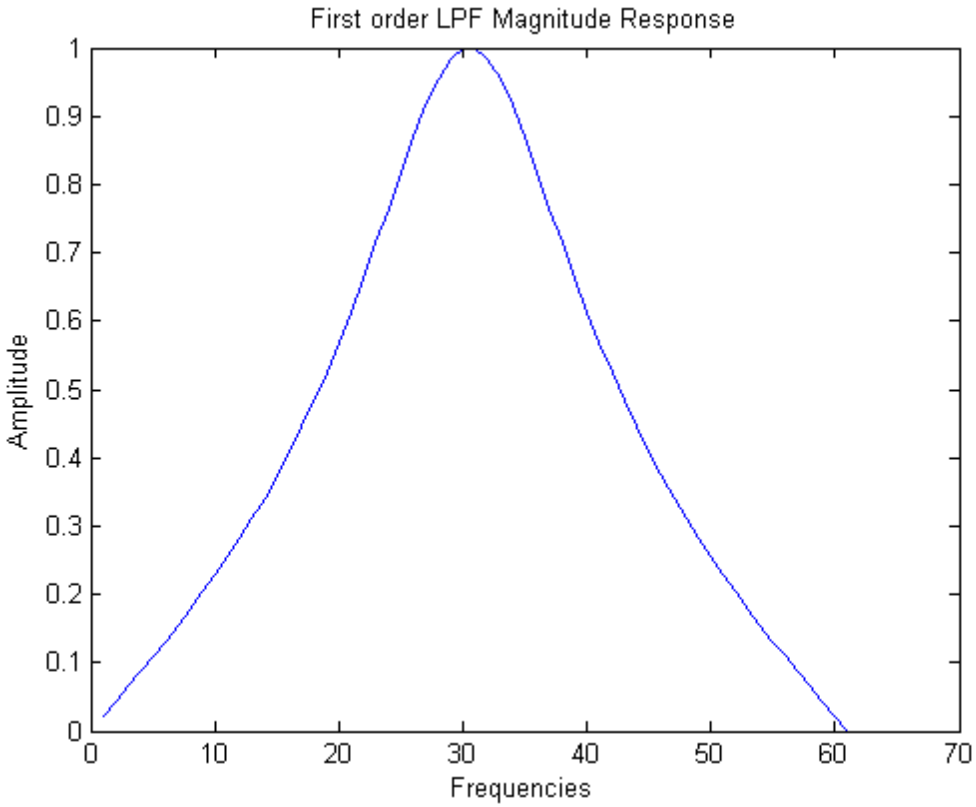
```
beta=0.8;
alpha=0.5;

h_bandstop_b8a6=zeros(1,61);
diff=(2*pi)/61;
for i=1:61
    w=(-1*pi)+ (i*diff);
    h_bandstop_b8a6(i)=1/( 1-(beta*(alpha+1)*exp(-1*1j*w))+(alpha*exp(-2*1j*w)) );
    h_bandstop_b8a6(i)=h_bandstop_b8a6(i)*(1-(2*beta*exp(-1*1j*w))+exp(-2*1j*w));
    h_bandstop_b8a6(i)=h_bandstop_b8a6(i)*((1+alpha)/2);
end

h_bandstop_abs_b8a6=abs(h_bandstop_b8a6);
h_bandstop_phase_b8a6=phase(h_bandstop_b8a6);
level=max(h_bandstop_abs_b8a6)/sqrt(2);

level1=level+0.05;
level2=level-0.05;
count=1;

for i=1:61
    if level1>h_bandstop_abs_b8a6(i) && level2<h_bandstop_abs_b8a6(i)
        h_bandstop_b8a6_3db(count)=h_bandstop_abs_b8a6(i);
        h_bandstop_b8a6_index(count)=i;
        count=count+1;
    end
end
h_bandstop_b8a6_3db_band=(40-20)*diff;
```

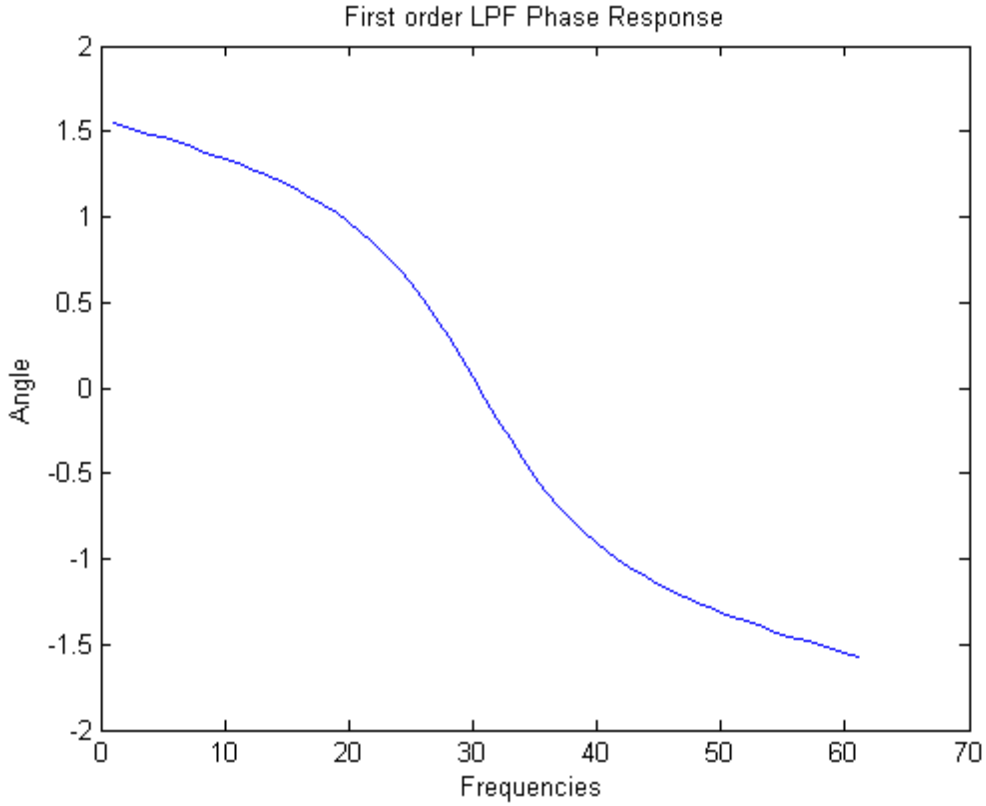
```
Q_bandstop_b8a6=acos(beta)/h_bandstop_b8a6_3db_band;
```

Result

- **Plot for the Question No 1(a)**

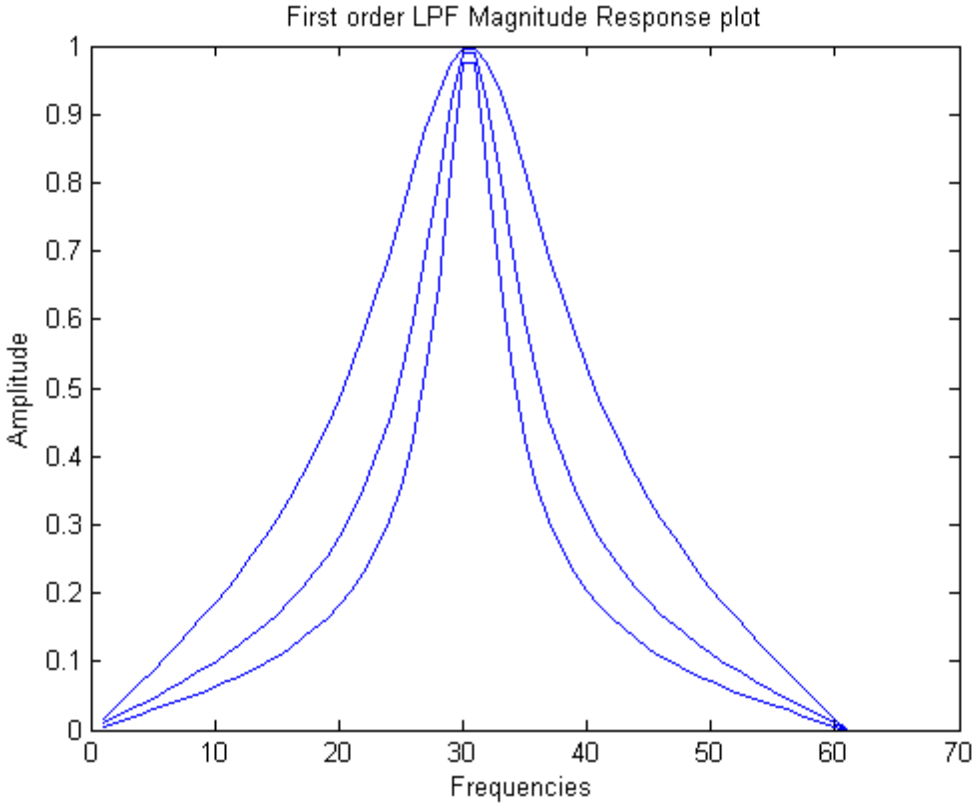
```
figure;plot(H_lp_abs);
title('First order LPF Magnitude Response');
xlabel('Frequencies');ylabel('Amplitude');

figure;plot(H_lp_phase);
title('First order LPF Phase Response');
xlabel('Frequencies');ylabel('Angle');
```





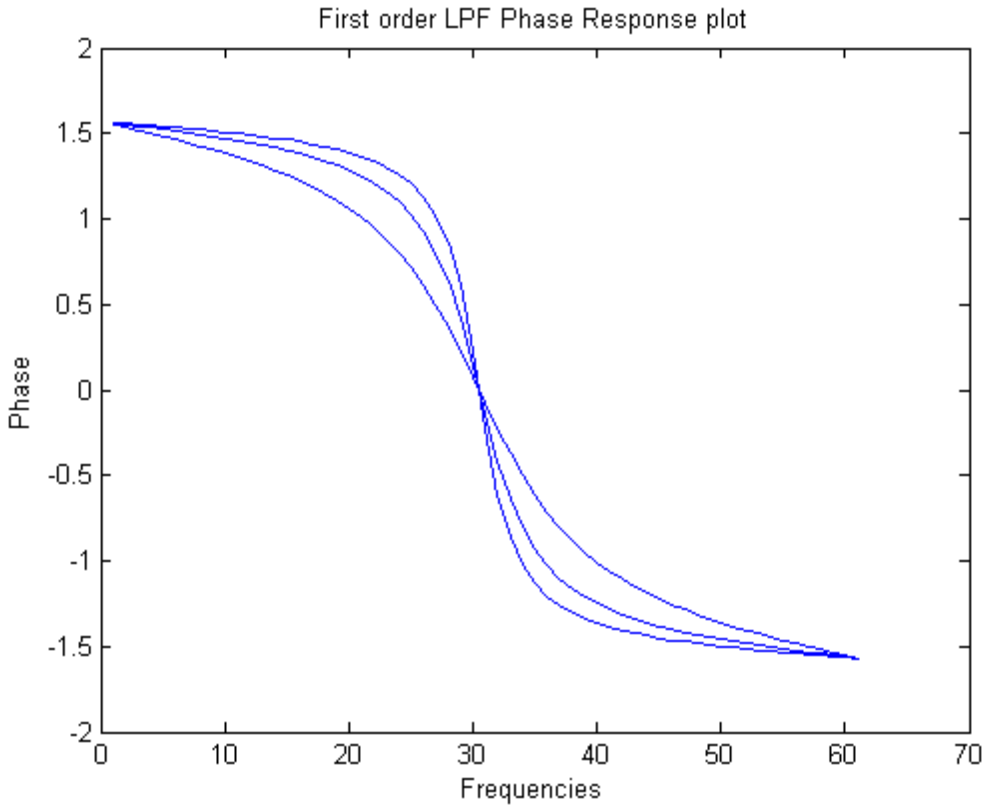
- **Plot for the Question No 1(b)**

```
figure;plot(H_lp_abs_point5);
title('First order LPF Magnitude Response plot');
xlabel('Frequencies');ylabel('Amplitude');
hold on
plot(H_lp_abs_point7);
hold on
plot(H_lp_abs_point8);
```



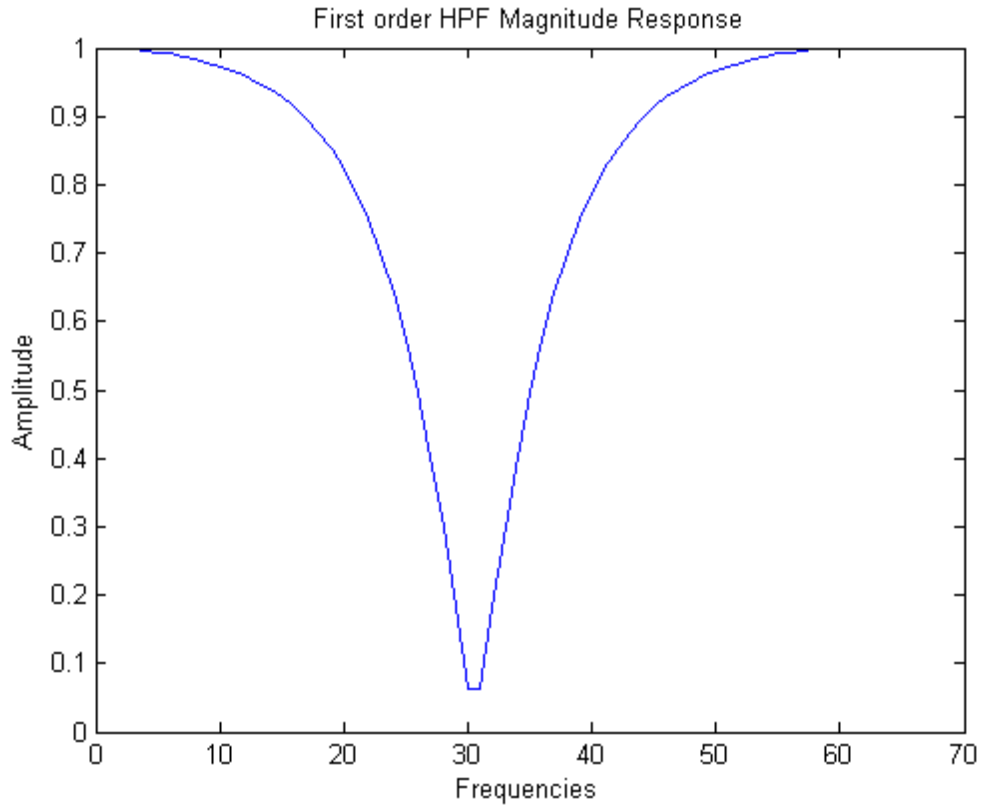
- **Plot for the Question No 1(b)**

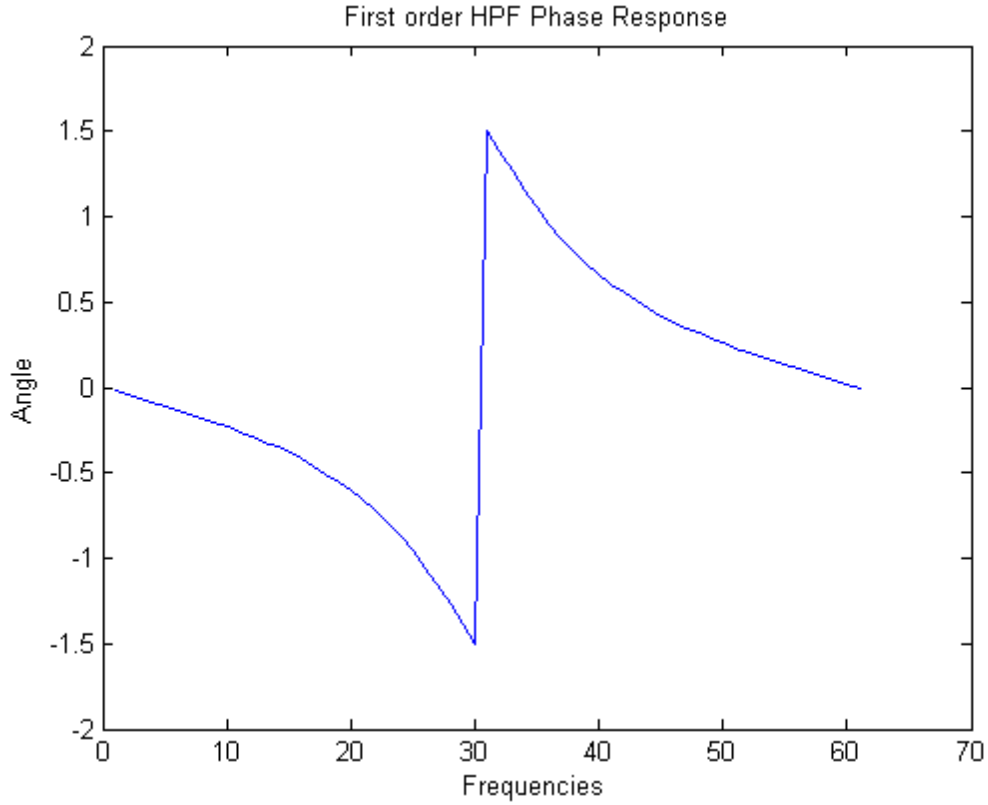
```
figure;plot(H_lp_phase_point5);
title('First order LPF Phase Response plot');
xlabel('Frequencies');ylabel('Phase');
hold on
plot(H_lp_phase_point7);
hold on
plot(H_lp_phase_point8);
```



- **Plot for the Question No 2(a)**

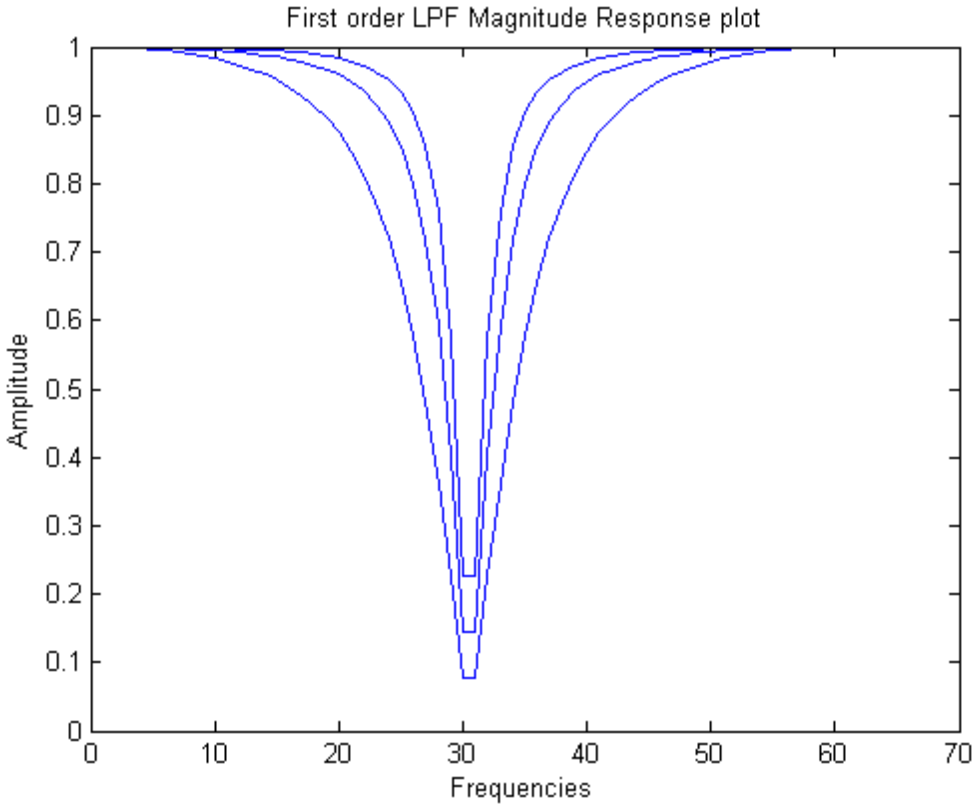
```
figure;plot(H_hp_abs);
title('First order HPF Magnitude Response');
xlabel('Frequencies');ylabel('Amplitude');

figure;plot(H_hp_phase);
title('First order HPF Phase Response');
xlabel('Frequencies');ylabel('Angle');
```


First order HPF Magnitude Response
Amplitude
Frequencies
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
10
20
30
40
50
60
70


First order HPF Phase Response
Angle
Frequencies
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
10
20
30
40
50
60
70

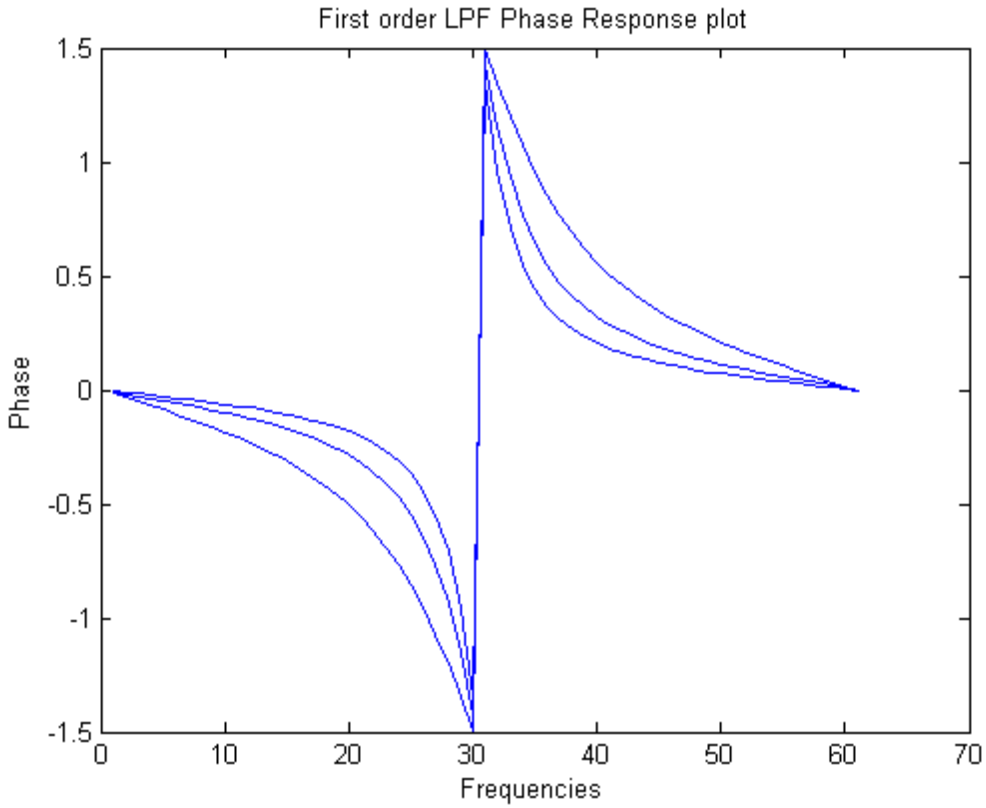
- **Plot for the Question No 2(b)**

```
figure;plot(H_hp_abs_point5);
title('First order LPF Magnitude Response plot');
xlabel('Frequencies');ylabel('Amplitude');
hold on
plot(H_hp_abs_point7);
hold on
plot(H_hp_abs_point8);
```



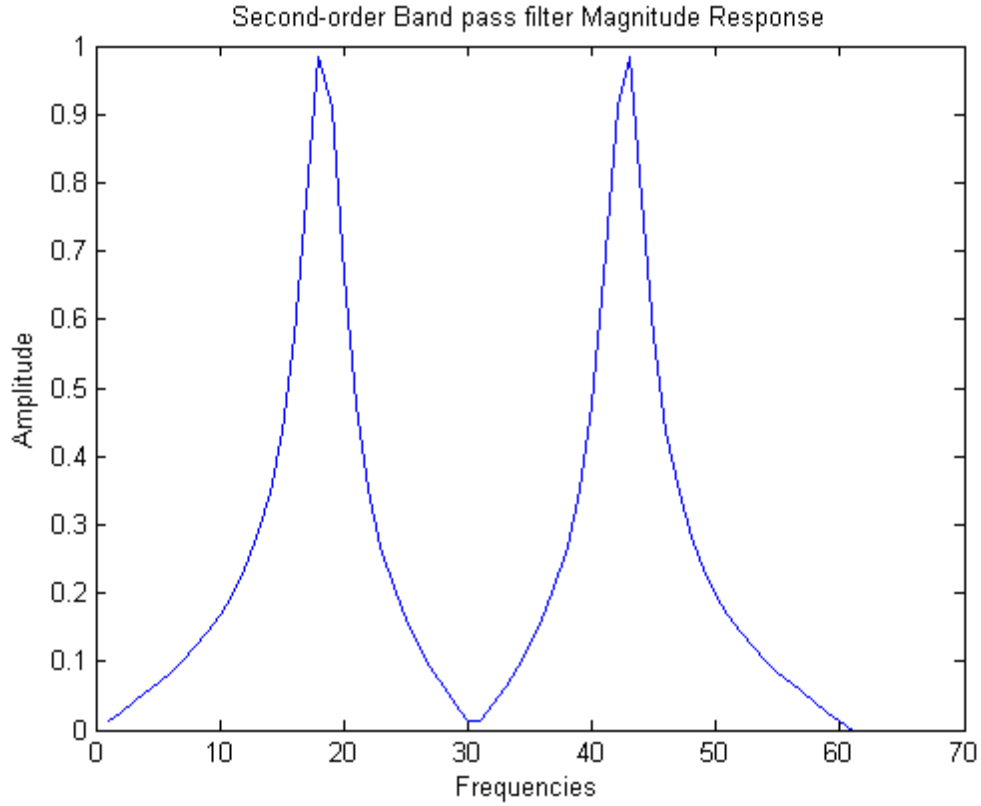
- **Plot for the Question No 2(b)**

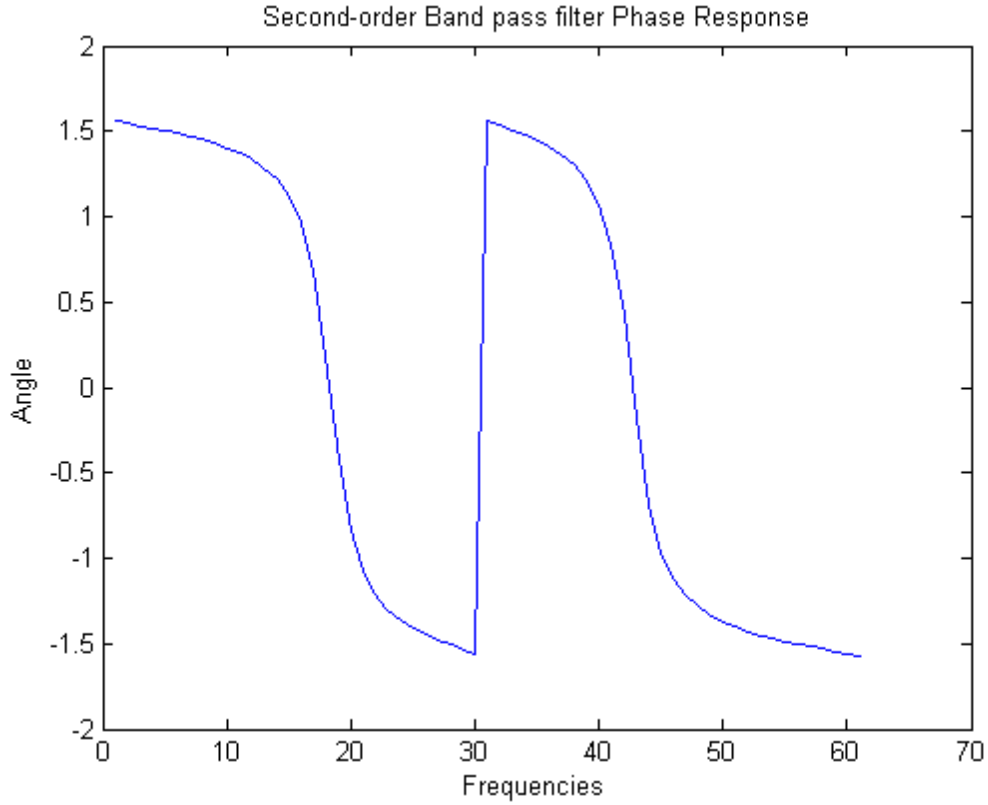
```
figure;plot(H_hp_phase_point5);
title('First order LPF Phase Response plot');
xlabel('Frequencies');ylabel('Phase');
hold on
plot(H_hp_phase_point7);
hold on
plot(H_hp_phase_point8);
```



- **Plot for the Question No 3(a)**

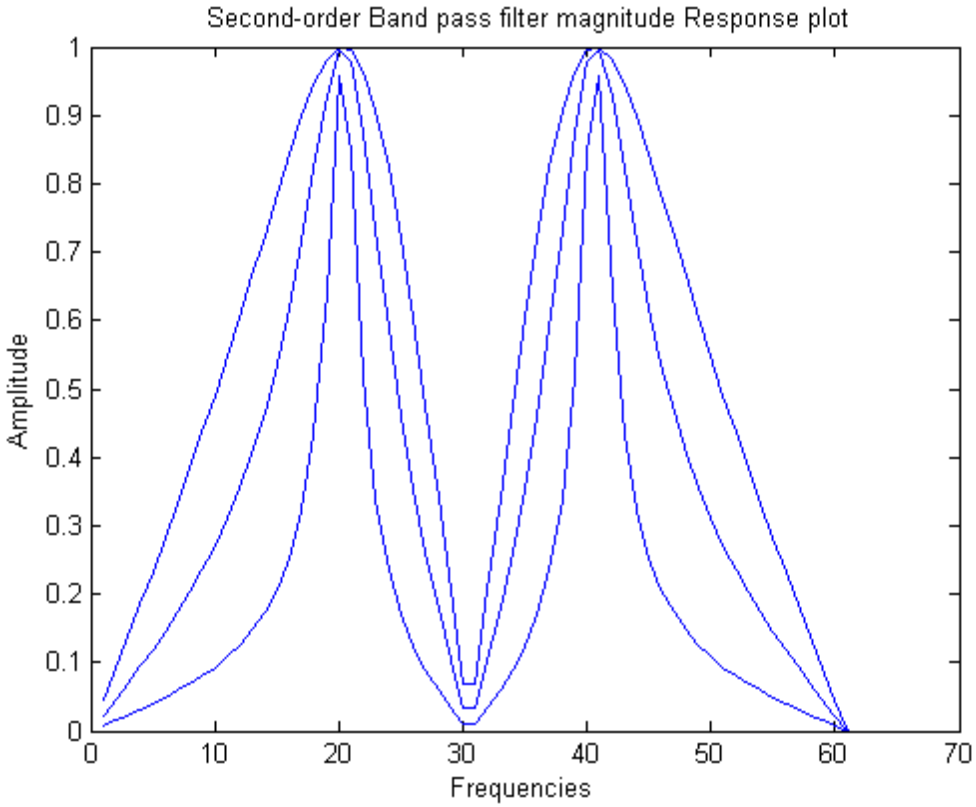
```
figure;plot(h_bandpass_abs);
title('Second-order Band pass filter Magnitude Response');
xlabel('Frequencies');ylabel('Amplitude');

figure;plot(h_bandpass_phase);
title('Second-order Band pass filter Phase Response');
xlabel('Frequencies');ylabel('Angle');
```


Second-order Band pass filter Magnitude Response
Amplitude
Frequencies
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
10
20
30
40
50
60
70


Second-order Band pass filter Phase Response
Angle
Frequencies
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
10
20
30
40
50
60
70

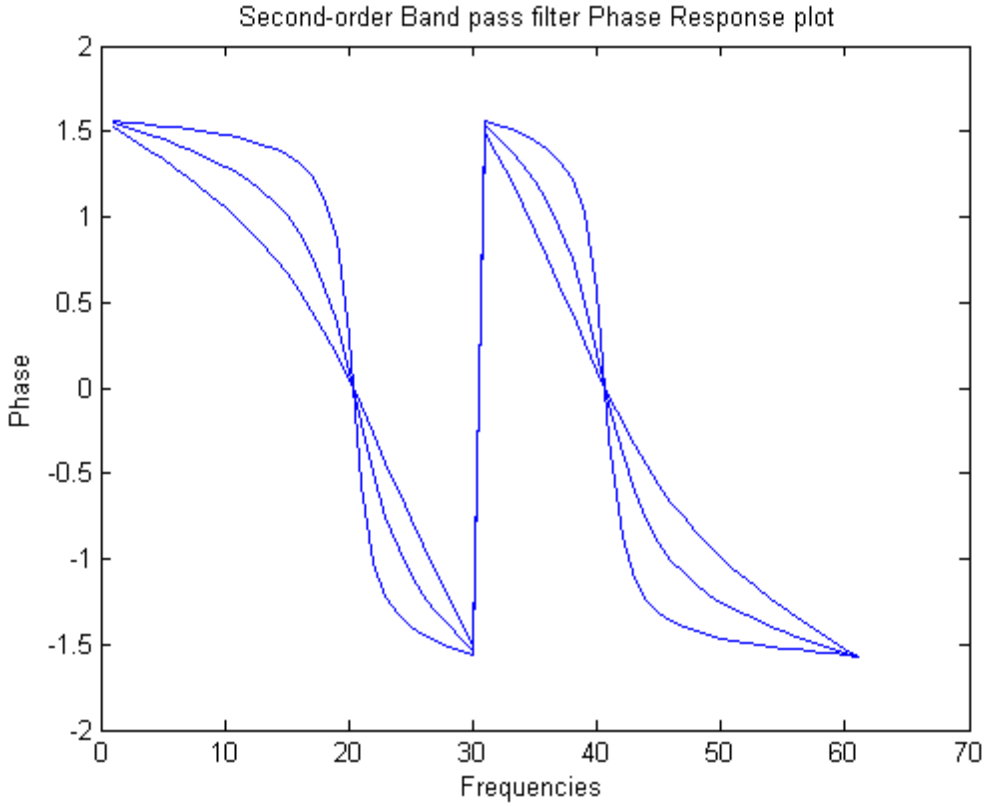
- **Plot for the Question No 3(b)**

```
figure;plot(h_bandpass_abs_a2b5);
title(' Second-order Band pass filter magnitude Response plot');
xlabel('Frequencies');ylabel('Amplitude');
hold on
plot(h_bandpass_abs_a5b5);
hold on
plot(h_bandpass_abs_a8b5);
```



- **Plot for the Question No 3(b)**

```
figure;plot(h_bandpass_phase_a2b5);
title(' Second-order Band pass filter Phase Response plot');
xlabel('Frequencies');ylabel('Phase');
hold on
plot(h_bandpass_phase_a5b5);
hold on
plot(h_bandpass_phase_a8b5);
```



• **Result for the Question No 3(b)** 3db Bandwidth for a=0.2 and beta=0.5

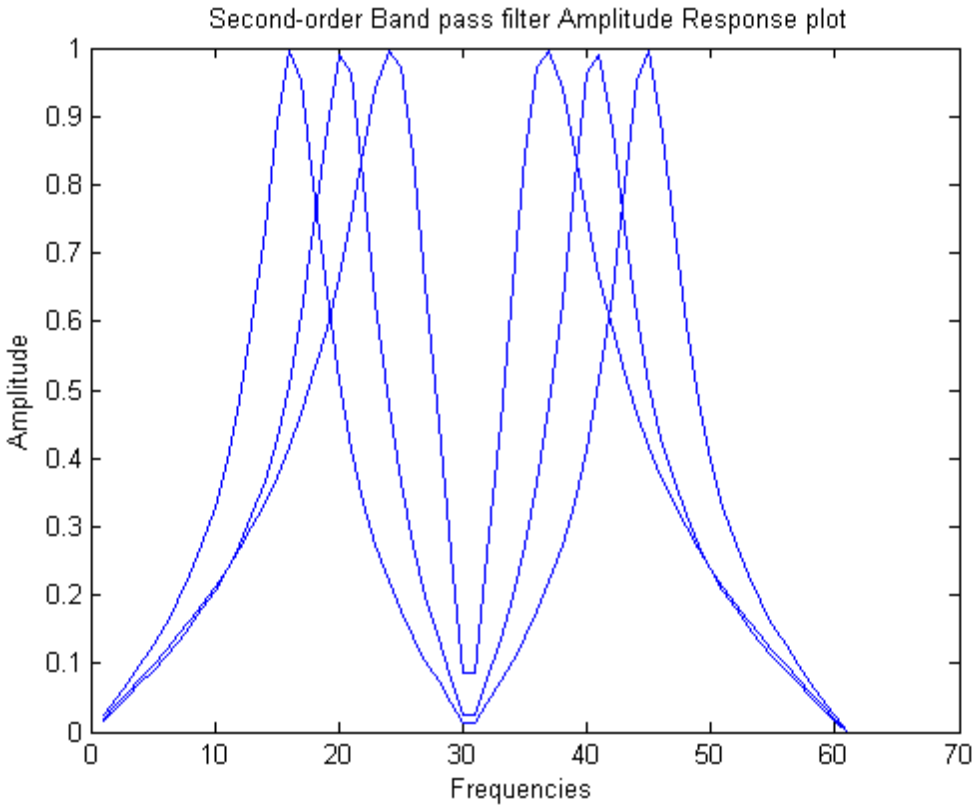
```
h_bandpass_a2b5_3db_band
% Quality factor for a=0.2 and beta=0.5
Q_bandpass_a2b5
% 3db Bandwidth for a=0.5 and beta=0.5
h_bandpass_a5b5_3db_band
% Quality factor for a=0.5 and beta=0.5
Q_bandpass_a5b5
% 3db Bandwidth for a=0.8 and beta=0.5
h_bandpass_a8b5_3db_band
% Quality factor for a=0.8 and beta=0.5
Q_bandpass_a8b5
```

```
h_bandpass_a2b5_3db_band =

    2.3691


Q_bandpass_a2b5 =

    0.4420


h_bandpass_a5b5_3db_band =
```

```
    2.3691

Q_bandpass_a5b5 =

    0.4420

h_bandpass_a8b5_3db_band =

    2.3691

Q_bandpass_a8b5 =

    0.4420
```

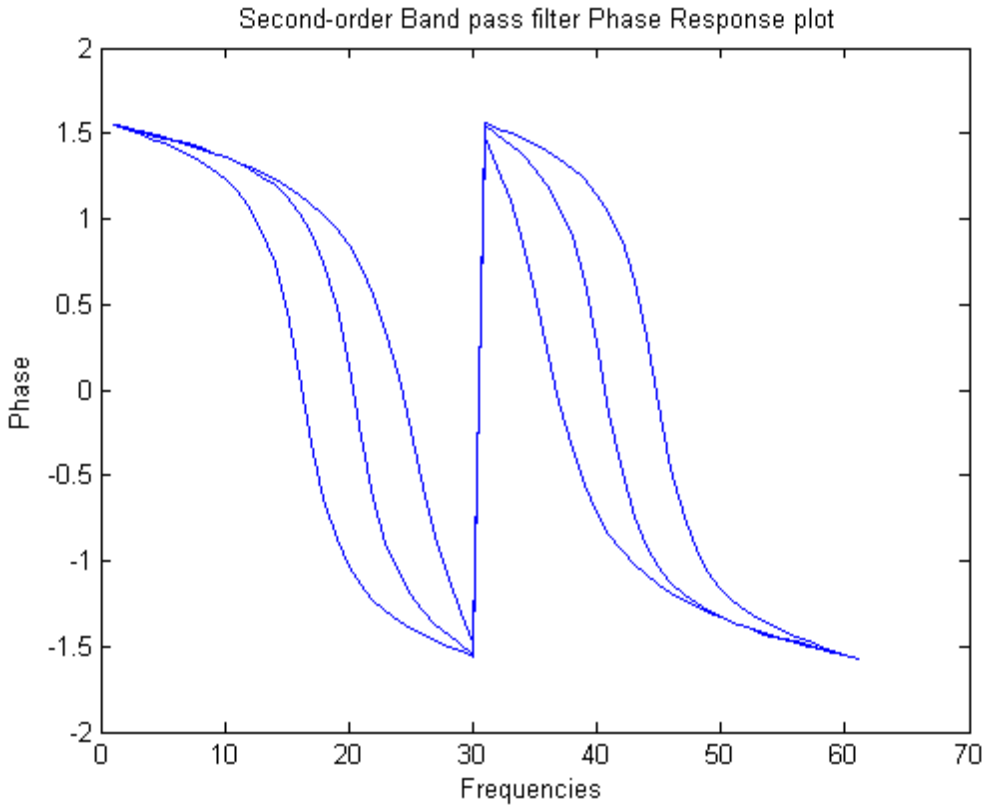
- **Plot for the Question No 3(d)**

```
figure;plot(h_bandpass_abs_b1a6);
title(' Second-order Band pass filter Amplitude Response plot');
xlabel('Frequencies');ylabel('Amplitude');
hold on
plot(h_bandpass_abs_b5a6);
hold on
plot(h_bandpass_abs_b8a6);
```



• **Plot for the Question No 3(d)**

```
figure;plot(h_bandpass_phase_b1a6);
title(' Second-order Band pass filter Phase Response plot');
xlabel('Frequencies');ylabel('Phase');
hold on
plot(h_bandpass_phase_b5a6);
hold on
plot(h_bandpass_phase_b8a6);
```



• **Result for the Question No 3(d)** 3db Bandwidth for a=0.6 and beta=0.1

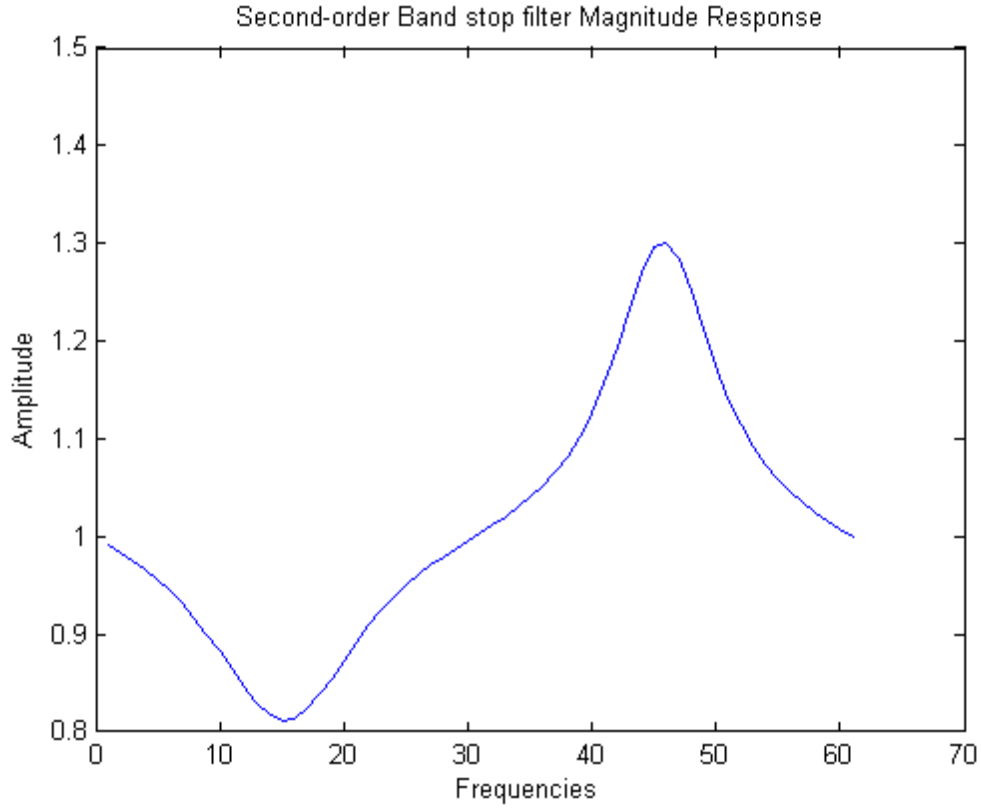
```
h_bandpass_b1a6_3db_band
% Quality factor for a=0.6 and beta=0.1
Q_bandpass_b1a6
% 3db Bandwidth for a=0.6 and beta=0.5
h_bandpass_b5a6_3db_band
% Quality factor for a=0.6 and beta=0.5
Q_bandpass_b5a6
% 3db Bandwidth for a=0.6 and beta=0.8
h_bandpass_b8a6_3db_band
% Quality factor for a=0.6 and beta=0.8
Q_bandpass_b8a6
```

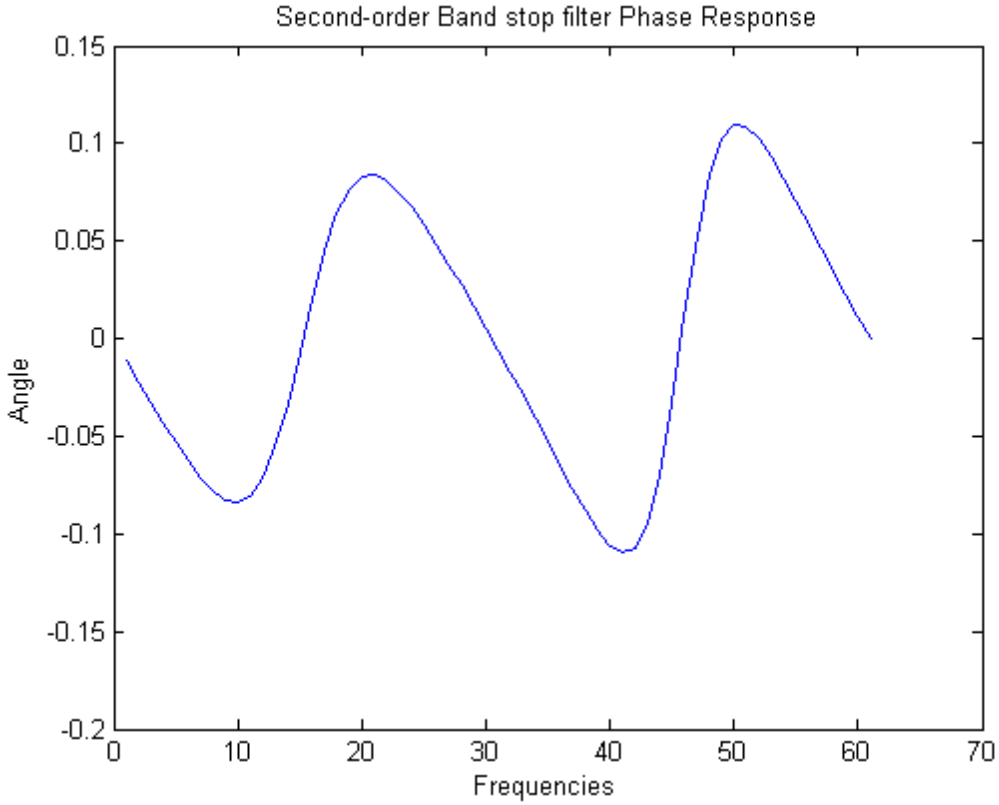
h_bandpass_b1a6_3db_band =

```
    3.3991


Q_bandpass_b1a6 =

    0.4327


h_bandpass_b5a6_3db_band =

    2.5751


Q_bandpass_b5a6 =

    0.4067


h_bandpass_b8a6_3db_band =

    2.0601


Q_bandpass_b8a6 =

    0.3124
```

- **Plot for the Question No 4(a)**

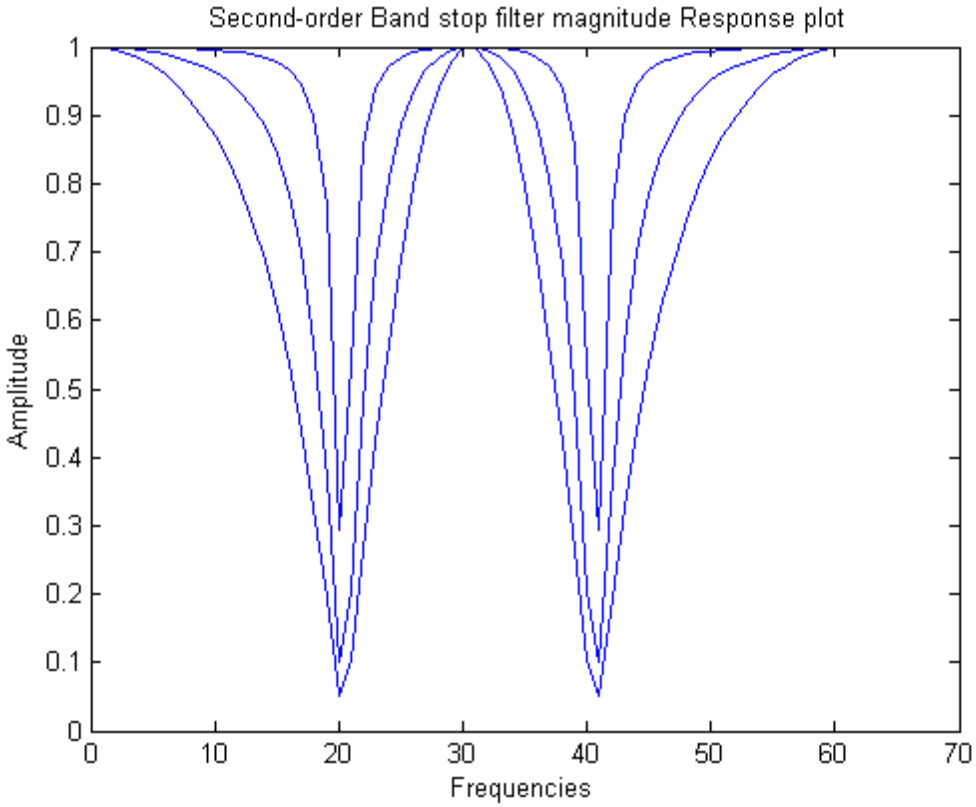
```
figure;plot(h_bandstop_abs);
title('Second-order Band stop filter Magnitude Response');
xlabel('Frequencies');ylabel('Amplitude');

figure;plot(h_bandstop_phase);
title('Second-order Band stop filter Phase Response');
xlabel('Frequencies');ylabel('Angle');
```


Second-order Band stop filter Magnitude Response
Amplitude
Frequencies
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0
10
20
30
40
50
60
70


Second-order Band stop filter Phase Response
Angle
Frequencies
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
0
10
20
30
40
50
60
70

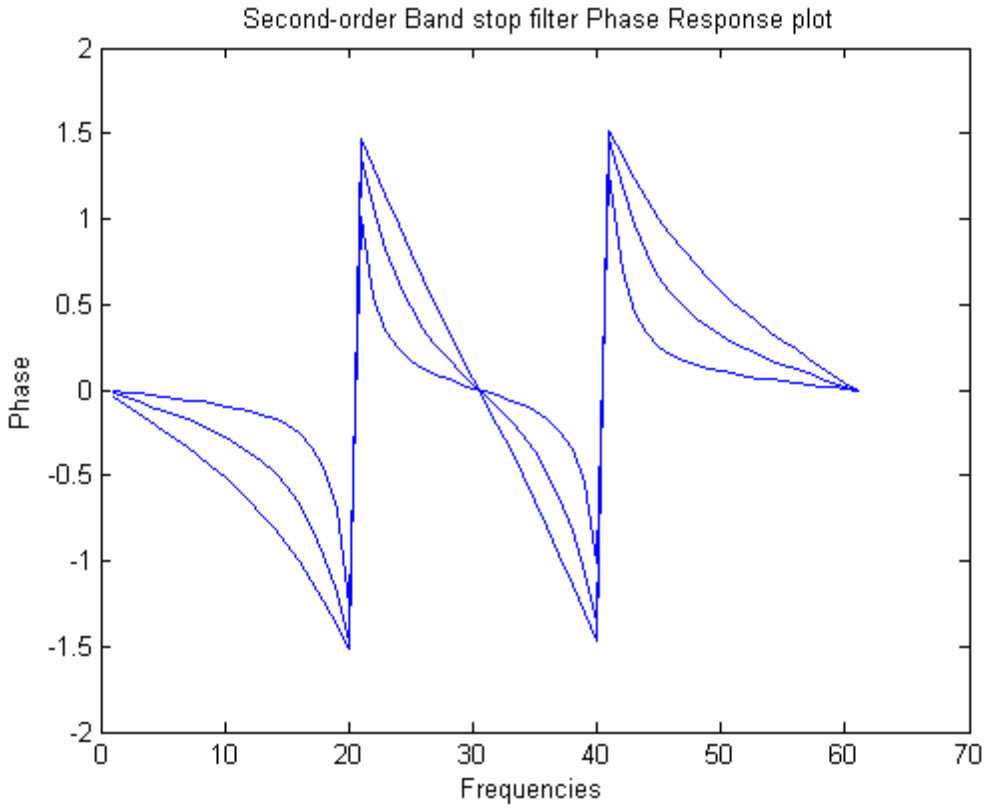
- **Plot for the Question No 4(b)**

```
figure;plot(h_bandstop_abs_a2b5);
title(' Second-order Band stop filter magnitude Response plot');
xlabel('Frequencies');ylabel('Amplitude');
hold on
plot(h_bandstop_abs_a5b5);
hold on
plot(h_bandstop_abs_a8b5);
```



- **Plot for the Question No 4(b)**

```
figure;plot(h_bandstop_phase_a2b5);
title(' Second-order Band stop filter Phase Response plot');
xlabel('Frequencies');ylabel('Phase');
hold on
plot(h_bandstop_phase_a5b5);
hold on
plot(h_bandstop_phase_a8b5);
```



• **Result for the Question No 4(b)** 3db Bandwidth for a=0.2 and beta=0.5

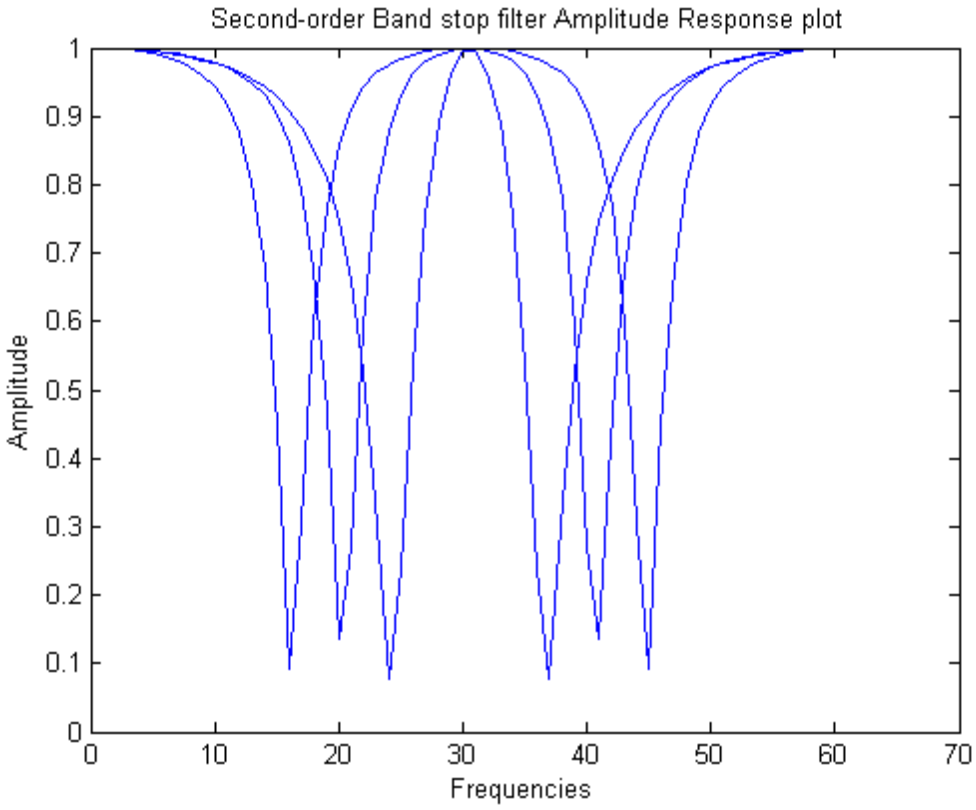
```
h_bandstop_a2b5_3db_band
% Quality factor for a=0.2 and beta=0.5
Q_bandstop_a2b5
% 3db Bandwidth for a=0.5 and beta=0.5
h_bandstop_a5b5_3db_band
% Quality factor for a=0.5 and beta=0.5
Q_bandstop_a5b5
% 3db Bandwidth for a=0.8 and beta=0.5
h_bandstop_a8b5_3db_band
% Quality factor for a=0.8 and beta=0.5
Q_bandstop_a8b5
```

```
h_bandstop_a2b5_3db_band =

    1.1330


Q_bandstop_a2b5 =

    0.9242


h_bandstop_a5b5_3db_band =
```

```
    2.7811

Q_bandstop_a5b5 =

    0.3765

h_bandstop_a8b5_3db_band =

    2.3691

Q_bandstop_a8b5 =

    0.4420
```

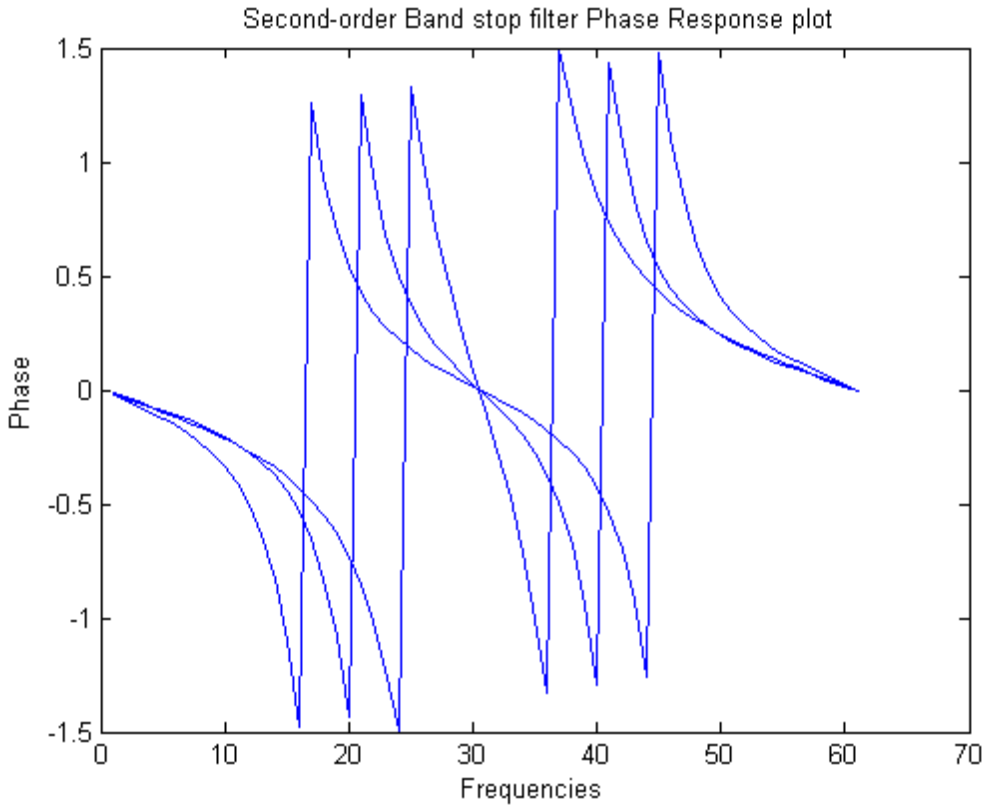
- **Plot for the Question No 3(d)**

```
figure;plot(h_bandstop_abs_b1a6);
title(' Second-order Band stop filter Amplitude Response plot');
xlabel('Frequencies');ylabel('Amplitude');
hold on
plot(h_bandstop_abs_b5a6);
hold on
plot(h_bandstop_abs_b8a6);
```



- **Plot for the Question No 3(d)**

```
figure;plot(h_bandstop_phase_b1a6);
title(' Second-order Band stop filter Phase Response plot');
xlabel('Frequencies');ylabel('Phase');
hold on
plot(h_bandstop_phase_b5a6);
hold on
plot(h_bandstop_phase_b8a6);
```



- **Result for the Question No 3(d)** 3db Bandwidth for a=0.6 and beta=0.1

```
h_bandstop_b1a6_3db_band
% Quality factor for a=0.6 and beta=0.1
Q_bandstop_b1a6
% 3db Bandwidth for a=0.6 and beta=0.5
h_bandstop_b5a6_3db_band
% Quality factor for a=0.6 and beta=0.5
Q_bandstop_b5a6
% 3db Bandwidth for a=0.6 and beta=0.8
h_bandstop_b8a6_3db_band
% Quality factor for a=0.6 and beta=0.8
Q_bandstop_b8a6
```

h_bandstop_b1a6_3db_band =

```
    3.3991

Q_bandstop_b1a6 =

    0.4327

h_bandstop_b5a6_3db_band =

    2.5751

Q_bandstop_b5a6 =

    0.4067

h_bandstop_b8a6_3db_band =

    2.0601

Q_bandstop_b8a6 =

    0.3124
```

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