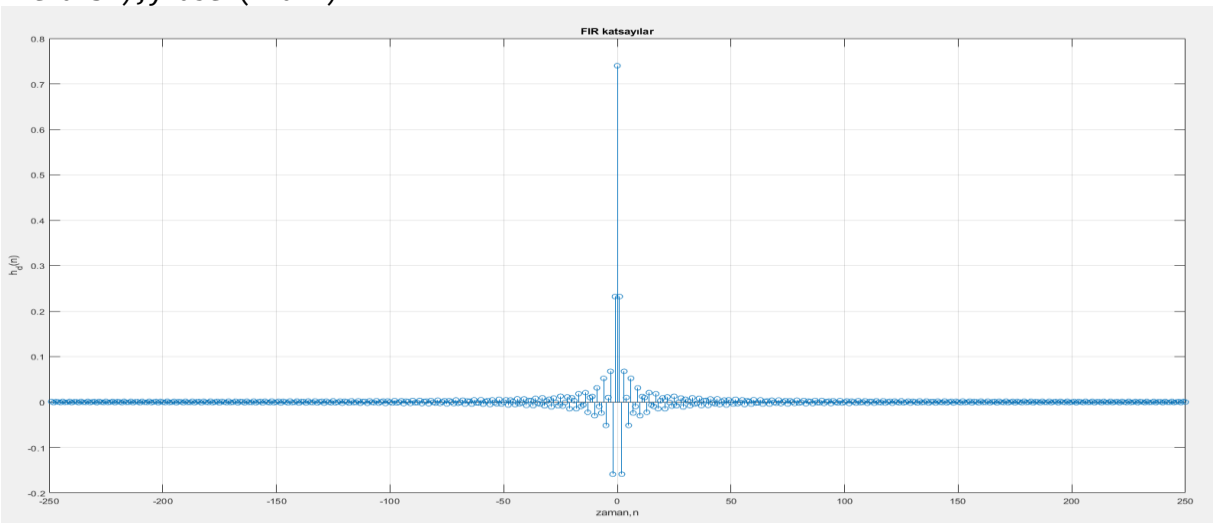
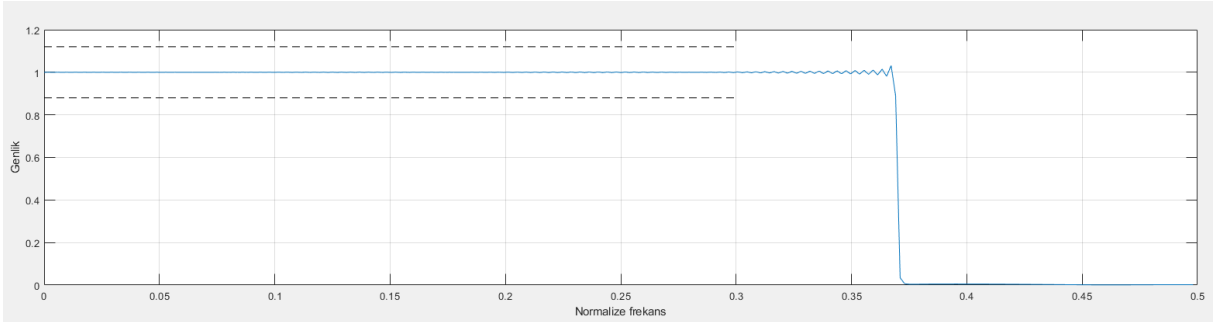
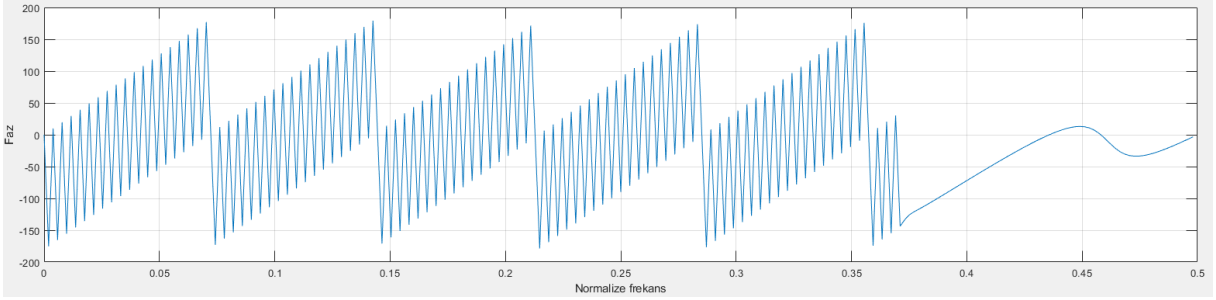
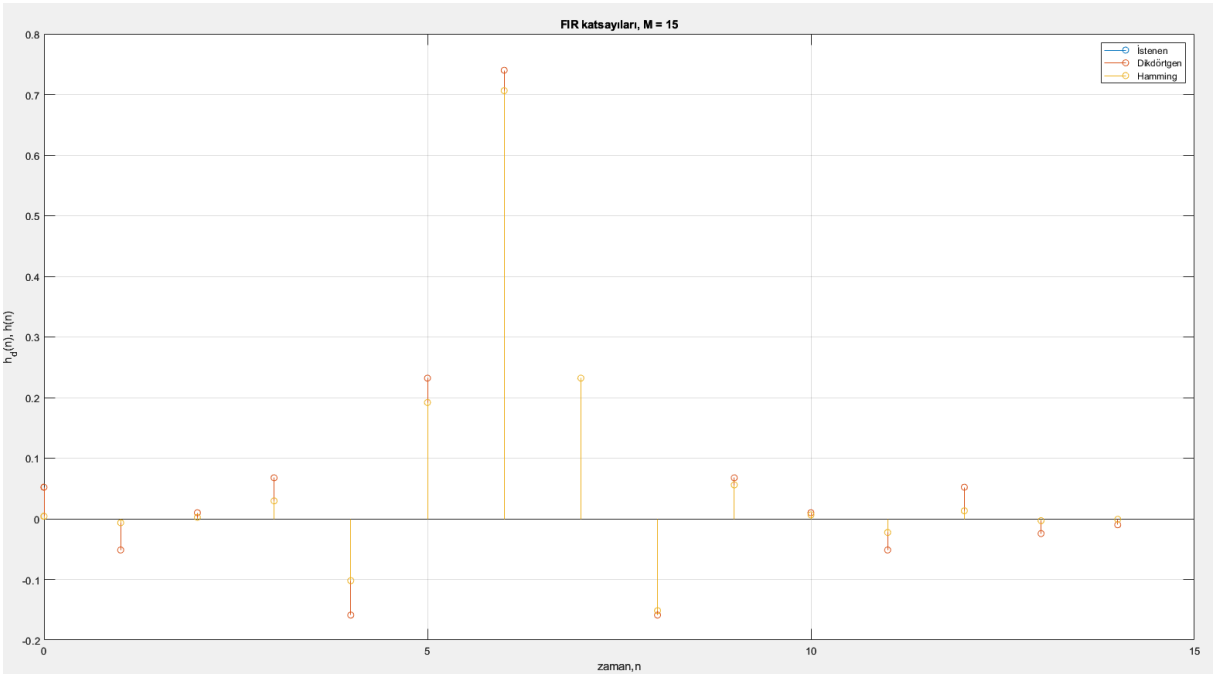
```
% eem423_411_FIR.m
% EEM 423 Digital Signal Processing / EEM 411 Sayısal İşaret İşleme
% Pencere Yaklaşımı ile FIR filtre tararım uygulaması
% Tasarım İsterleri
wc = 2*pi*0.37;



wp = 2*pi*0.3;


ws = 2*pi*0.5;


d1=0.12;


d2=0.08;


% Arzu edilen (M-1)/2 kadar kaydırılan FIR filtre katsayıları
Md = 501; nn = (1:Md)-(Md-1)/2;
h_d = sin(wc*(nn))./(pi*(nn));  h_d((Md-1)/2) = wc/pi;
figure(1),
stem(nn,h_d),grid,axis([-(Md-1)/2 (Md-1)/2
ylim]),xlabel('zaman,n'),ylabel('h_d(n)'),title('FIR katsayılar')
% Frekans Cevanını elde edelim
[Hd,w] = freqz(h_d,1,256);
figure(2)
subplot(211),plot(w/pi/2,abs(Hd),[0 wp/pi/2],(1+d1)*[1 1],'k--',[0 wp/pi/2],(1-
d1)*[1 1],'k--',[ws/pi/2 0.5],(d2)*[1 1],'k--'),grid,xlabel('Normalize
frekans'),ylabel('Genlik')
subplot(212),plot(w/pi/2,angle(Hd)*180/pi),grid,xlabel('Normalize
frekans'),ylabel('Faz')
pause
% Tasarlanan FIR filtre uzunluğu
M = 15;



n = 0:M-1;h_ds = h_d((Md-1)/2-(M-1)/2+(1:M));
% ve dikdörtgen pencereden gecirilen
w_d = ones(1,M);  h_r = w_d.*h_ds;
figure(3),
stem(n,[h_ds',h_r']),grid,axis([0 M ylim]),xlabel('zaman,n'),ylabel('h_d(n),
h(n)'),title('FIR katsayılar')
% Frekans Cevabını elde edelim
[Hr,w] = freqz(h_r,1,256);
figure(4)
subplot(211),plot(w/pi/2,abs([Hd,Hr]),[0 wp/pi/2],(1+d1)*[1 1],'k--',[0
wp/pi/2],(1-d1)*[1 1],'k--',[ws/pi/2 0.5],(d2)*[1 1],'k--'),grid,xlabel('Normalize
frekans'),ylabel('Genlik')
subplot(212),plot(w/pi/2,angle([Hd,Hr])*180/pi),grid,xlabel('Normalize
frekans'),ylabel('Faz')
pause
% ve Hamming pencereden gecirilen
w_h = (0.54-0.46*cos(2*pi*n/(M-1)));   h_h = w_h.*h_ds;
```

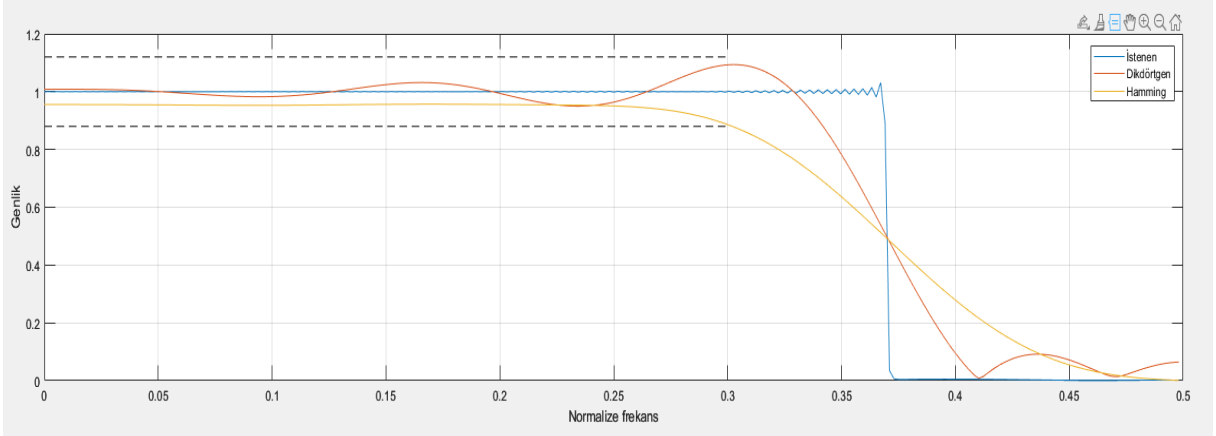
```
figure(3),clf
stem(n,[h_ds',h_r',h_h']),grid,axis([0 M ylim]),xlabel('zaman,n'),ylabel('h_d(n),
h(n)'),title(['FIR katsayıları, M = ',num2str(M)])
legend('İstenen','Dikdörtgen','Hamming')
% Frekans Cevabını elde edelim
[Hh,w] = freqz(h_h,1,256);
figure(4),clf
subplot(211),plot(w/pi/2,abs([Hd,Hr,Hh]),[0 wp/pi/2],(1+d1)*[1 1],'k--',[0
wp/pi/2],(1-d1)*[1 1],'k--',[ws/pi/2 0.5],(d2)*[1 1],'k--'),grid,xlabel('Normalize
frekans'),ylabel('Genlik')
legend('İstenen','Dikdörtgen','Hamming')
subplot(212),plot(w/pi/2,angle([Hd,Hr,Hb,Hh])*180/pi),grid,xlabel('Normalize
frekans'),ylabel('Faz')
pause
% MATLAB fir1 komutu ile de
b = fir1(M-1,wc/pi,rectwin(M),'noscale');
[H,w] = freqz(b,1,256);
figure(5),
subplot(311),stem(0:M-1,b),grid,xlabel('zaman, n'),ylabel('FIR katsaylar, h(n)')
subplot(312),plot(w/pi/2,abs(H),[0 wp/pi/2],(1+d1)*[1 1],'k--',[0 wp/pi/2],(1-
d1)*[1 1],'k--',[ws/pi/2 0.5],(d2)*[1 1],'k--'),grid,xlabel('Normalize
frekans'),ylabel('Genlik')
subplot(313),plot(w/pi/2,angle(H)*180/pi),grid,xlabel('Normalize
frekans'),ylabel('Faz')
pause
bh = fir1(M-1,wc/pi,hamming(M),'noscale');
[Hh,w] = freqz(bh,1,256);
figure(5),
subplot(311),stem(0:M-1,bh),grid,xlabel('zaman, n'),ylabel('FIR katsaylar, h(n)')
subplot(312),plot(w/pi/2,abs(Hh),[0 wp/pi/2],(1+d1)*[1 1],'k--',[0 wp/pi/2],(1-
d1)*[1 1],'k--',[ws/pi/2 0.5],(d2)*[1 1],'k--'),grid,xlabel('Normalize
frekans'),ylabel('Genlik')
subplot(313),plot(w/pi/2,angle(Hh)*180/pi),grid,xlabel('Normalize
frekans'),ylabel('Faz')
pause
legend('Dikdörtgen','Hamming')
subplot(313),plot(w/pi/2,angle([H,Hh])*180/pi),grid,xlabel('Normalize
frekans'),ylabel('Faz')
```



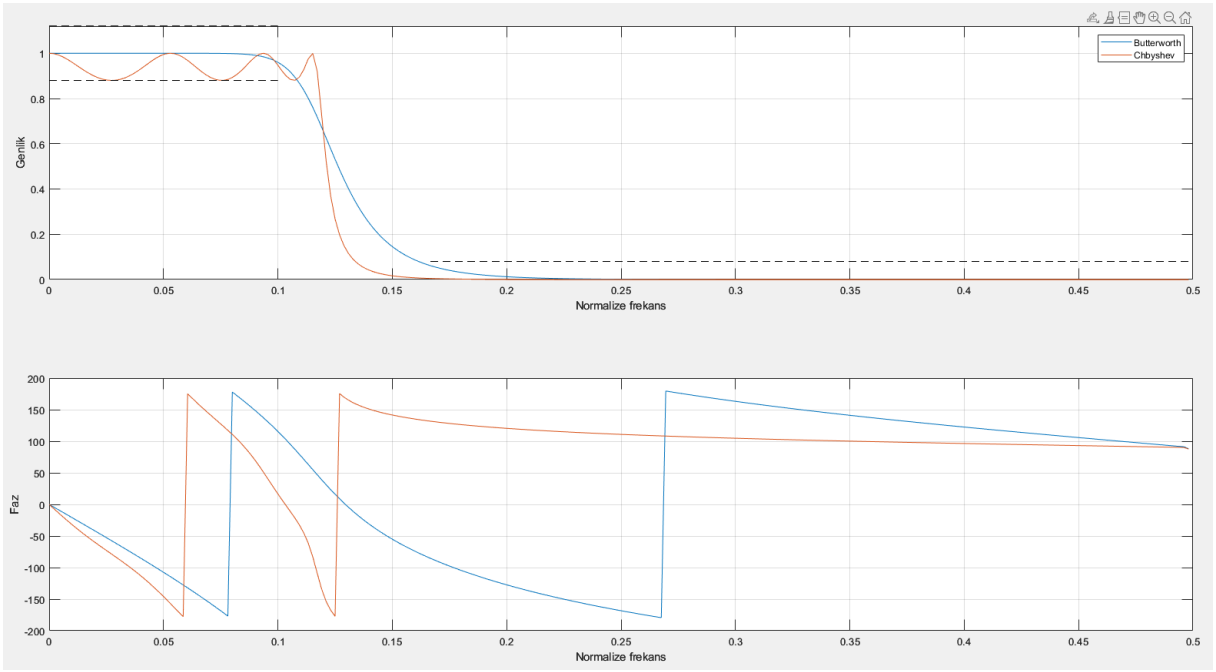

Genlik
Normalize frekans


Faz
Normalize frekans


FIR katsayıları, M = 15
İstenen
Dikdörtgen
Hamming
zaman,n


İstenen
Dikdörtgen
Hamming
Genlik
Normalize frekans

```
% eem423_411_IIR.m
% EEM 423 Digital Signal Processing / EEM 411 Sayısal İşaret İşleme
% IIR filtre tararım uygulaması
% Butterworth ve Chbyshev Analog filtre ve sayısallaştırılması
% Tasarım isterleri
wc = 2*pi*370;   wp = 2*pi*300; ws = 2*pi*500; d1=0.12;   d2=0.08;


Ts = 1/3000;


ww = 0:pi/Ts;
N = 7;



% Butterworth filtre tasarlayalım
[b,a] = butter(N,wc,'s')
[Hb] = freqs(b,a,ww);
figure(7)
subplot(211),plot(ww/(2*pi),abs(Hb),[0 wp]/(2*pi),(1+d1)*[1 1],'k--',[0
wp]/(2*pi),(1-d1)*[1 1],'k--',[ws ww(end)]/(2*pi),(d2)*[1 1],'k--'),grid,axis([0
ww(end)/(2*pi) ylim]),xlabel('frekans, Hz'),ylabel('Genlik')
subplot(212),plot(ww/(2*pi),angle(Hb)*180/pi),grid,axis([0 w(end)/(2*pi)
ylim]),xlabel('frekans, Hz'),ylabel('Faz')
% Sayısallaştıralım
[B,A] = tfdata(c2d(tf(b,a),Ts,'tustin'),'v')
[H,w] = freqz(B,A,256);
figure(8)
subplot(211),plot(w/(2*pi),abs(H),Ts*[0 wp]/(2*pi),(1+d1)*[1 1],'k--',Ts*[0
wp]/(2*pi),(1-d1)*[1 1],'k--',[Ts*ws w(end)]/(2*pi),(d2)*[1 1],'k--'),grid,axis([0
0.5 ylim]),xlabel('Normalize frekans'),ylabel('Genlik')
subplot(212),plot(w/(2*pi),angle(H)*180/pi),grid,axis([0 0.5
ylim]),xlabel('Normalize frekans'),ylabel('Faz')
% Chebyshev filtre tasarlayalım
[b,a] = cheby1(N,-20*log10(1-d1),wc,'s')
[Hc] = freqs(b,a,ww);
figure(7)
subplot(211),plot(ww/(2*pi),abs([Hb;Hc]),[0 wp]/(2*pi),(1+d1)*[1 1],'k--',[0
wp]/(2*pi),(1-d1)*[1 1],'k--',[ws ww(end)]/(2*pi),(d2)*[1 1],'k--'),grid,axis([0
ww(end)/(2*pi) ylim]),xlabel('frekans, Hz'),ylabel('Genlik')
legend('Butterworth','Chbyshev')
subplot(212),plot(ww/(2*pi),angle([Hb;Hc])*180/pi),grid,axis([0 ww(end)/(2*pi)
ylim]),xlabel('frekans, Hz'),ylabel('Faz')
% Sayısallaştıralım
[B,A] = tfdata(c2d(tf(b,a),Ts,'tustin'),'v')
[Hcd,w] = freqz(B,A,256);
figure(8)
subplot(211),plot(w/(2*pi),abs([H,Hcd]),Ts*[0 wp]/(2*pi),(1+d1)*[1 1],'k--',Ts*[0
wp]/(2*pi),(1-d1)*[1 1],'k--',[Ts*ws w(end)]/(2*pi),(d2)*[1 1],'k--'),grid,axis([0
0.5 ylim]),xlabel('Normalize frekans'),ylabel('Genlik')
legend('Butterworth','Chbyshev')
subplot(212),plot(w/(2*pi),angle([H,Hcd])*180/pi),grid,axis([0 0.5
ylim]),xlabel('Normalize frekans'),ylabel('Faz')
```


Butterworth
Chbyshev
Genlik
Normalize frekans

Faz
Normalize frekans