

```

1  function BandStopAba
2
3  %Author: Abarajithan G. : 150001C
4
5  clc;
6  close all;
7  clear all;
8
9  %Parameters
10 Ap_ = 0.05;      % Min Passband Ripple (db)
11 Aa_ = 40;        % Min Stopband Attenuation (db)
12 Wp1 = 400;       % Lower passband Freq (rad/s)
13 Wa1 = 500;       % Lower stopband Freq (rad/s)
14 Wa2 = 800;       % Higher stopband Freq (rad/s)
15 Wp2 = 950;       % Higher stopband Freq (rad/s)
16 Ws = 2600;       % Sampling Freq (rad/s)
17
18 Bt = min(Wa1-Wp1, Wp2-Wa2);
19
20 % 2. Choose Delta
21
22 delta_a = 10^(-Aa_/20);
23 c = 10 ^ ( Ap_ / 20);
24 delta_p = (c-1)/(c+1);
25 delta = min(delta_a, delta_p);
26
27 % 3. Get Aa from delta
28 Aa = -20*log10(delta);          % Actual stopband attenuation
29
30 % 4. Calculate alpha
31 if (Aa <= 21)
32     alpha = 0;
33 elseif ((21 < Aa) && (Aa <= 50))
34     alpha = 0.5842*(Aa-21)^0.4 + 0.07886*(Aa-21);
35 else
36     alpha = 0.1102*(Aa - 8.7);
37 end
38
39 % 5. Calculate D and N
40
41 if (Aa <= 21)
42     D = 0.9222;
43 else
44     D = (Aa - 7.95)/14.36;
45 end
46
47 N = ceil ( Ws * D / Bt +1);
48
49 if (mod(N,2) == 0)
50     N = N + 1;
51 end
52
53 % 6. Form Kaiser window
54
55 n = -(N-1)/2 :1: (N-1)/2 ;
56
57 beta = alpha*(1 - (2*n/(N-1)).^2).^0.5;
58 Ibeta = 0;
59 Ialpha = 0;
60
61 for k = 1 : 15          %10-15 are enough
62     Ibeta = Ibeta + ((1/factorial(k))*(beta/2).^k).^2;
63     Ialpha = Ialpha + ((1/factorial(k))*(alpha/2)^k)^2;
64 end
65 Ibeta = Ibeta + ones(1,numel(Ibeta));
66 Ialpha = Ialpha + ones(1,numel(Ialpha));
67
68 wk = Ibeta ./ Ialpha;
69

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70
71 figure;
72 stem(n,wk);
73 xlabel('n');
74 ylabel('w_k[n]');
75 title('Kaiser Window');
76
77 % 7. Impulse response h[n] of Bandstop
78
79 W1 = (Wp1+Wa1)/2;
80 W2 = (Wa2+Wp2)/2;
81
82 n1 = -(N-1)/2 : 1 : -1; %Negative range
83 n2 = 1 : 1 : (N-1)/2; %Positive range
84
85 h1 = ((1/pi)./n1).*(sin((2*pi)*W1/Ws.*n1) - sin((2*pi)*W2/Ws.*n1));
86 h0 = 1 + 2*(W1 - W2)/Ws;
87 h2 = ((1/pi)./n2).*(sin((2*pi)*W1/Ws.*n2) - sin((2*pi)*W2/Ws.*n2));
88
89 h_ideal = [h1,h0,h2];
90 n = [n1,0,n2];
91
92 figure;
93 stem(n,h_ideal);
94
95 xlabel('n');
96 ylabel('h[n]');
97 title('Impulse Response of Expected Ideal Filter');
98
99 % Applying the Window
100
101 h_final = h_ideal .* wk; % Non causal Filter
102
103 figure;
104 stem(n,h_final);
105 xlabel('n');
106 ylabel('h[n]');
107 title('Non-causal Filter: Impulse Response');
108
109
110 stem( 1:size(h_final, 2) ,h_final);
111
112 xlabel('n');
113 ylabel('h[n]');
114 title('Causal Filter: Impulse Response')
115
116 % Inspect the filter's magnitude, phase response, group delay and phase
117 % delay
118
119 fvtool(h_final);
120
121 % Creating Given Excitation
122
123 n = 0 : 1 : 250;
124 l = size(n,2);
125
126 We1 = W1/2
127 We2 = (W2+W1)/2
128 We3 = (Ws/2+W2)/2
129
130 T = 2*pi/Ws;
131 x = sin(We1*T*n) + sin(We2*T*n) + sin(We3*T*n); %Excitation Signal
132
133 % Taking Discrete Fourier Transform of Excitation
134
135 NFFT = 2^nextpow2(l);
136 X = fft( x , NFFT) / l;
137 f = (Ws)/2 * linspace(0, 1, NFFT/2+1);
138 mag = 2*abs(X(1:NFFT/2+1));

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139
140 figure;
141 plot(f , mag);
142
143 title('DFT of Excitation Signal')
144 xlabel('Frequency (rad/s)')
145 ylabel('|X(w)|');
146
147 % Applying the filter to the excitation
148
149 x_filtered = conv(x , h_final);
150 X_filtered = fft(x_filtered,NFFT)/l;
151 mag = 2*abs(X_filtered(1:NFFT/2+1));
152
153 figure;
154 plot(f,mag);
155 title('DFT of Excitation Passed Through Filter')
156 xlabel('Frequency (rad/s)')
157 ylabel('|X_k(w)|');
158
159 %Passing the excitation through an ideal bandstop filter
160
161 x_idealFiltered = sin(We1*T*n) + sin(We3*T*n);
162 X_idealFiltered = fft(x_idealFiltered,NFFT)/l;
163 mag = 2*abs(X_idealFiltered(1:NFFT/2+1));
164
165 figure;
166 plot(f,mag);
167 title('DFT of Excitation through an Ideal Filter')
168 xlabel('Frequency (rad/s)')
169 ylabel('|X_i(w)|');
170
171
172 % Plotting Excitation
173
174 figure;
175 plot(x);
176 title('Time doman Response of Excitation')
177 xlabel('Time(s)')
178 ylabel('x[n]');
179 axis([50,250, -2.5,2.5]);
180
181 figure;
182 plot(x_filtered);
183 title('Time doman Response of Filtered Excitation')
184 xlabel('Time(s)')
185 ylabel('x[n]');
186 axis([50,250, -2.5,2.5]);
187
188
189 alpha
190 D
191 N
192 Bt
193
194
195
196
197
198
199
200
201
202
203
204
205

```