
Yankee Bush Software LLC
Digital FIR Low-Pass Filter Design

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Problem Description

Design a digital FIR lowpass filter to meet the following specifications:

$$\omega_p = 0.22\pi, \quad R_p = 0.3\ dB$$
$$\omega_s = 0.32\pi, \quad A_s = 52\ dB$$

Choose an appropriate window function from the following table.

Window name	Transition width, $\Delta\omega$ *Approximate*	*Exact*	Minimum stopband attenuation in dB
Rectangular	$\frac{4\pi}{M}$	$\frac{1.8\pi}{M}$	21
Bartlett	$\frac{8\pi}{M}$	$\frac{6.1\pi}{M}$	25
Hanning	$\frac{8\pi}{M}$	$\frac{6.2\pi}{M}$	44
Hamming	$\frac{8\pi}{M}$	$\frac{6.6\pi}{M}$	53
Blackman	$\frac{12\pi}{M}$	$\frac{11\pi}{M}$	74

Determine the impulse response and plot the frequency response of the designed filter (magnitude response in dB).

Matlab Source Code

```
% design of low pass FIR filter
clc;
clear all;
wp=0.22;% normalize frequency
ws=0.32;
Rp=0.3;% in db
As=52; % in db
tr_width = ws - wp;
M = ceil(6.6*pi/tr_width) + 1;
delta_w = 2*pi/1000;
Rp = -(min(db(1:1:wp/delta_w+1))) ; % Passband Ripple
As = -round(max(db(ws/delta_w+1:1:501))); % Min Stopband attenuation
% chosen hamming window
f = [0 0.22 0.32 1]; m = [1 1 0 0];
b = fir2(M,f,m);
figure(1)
freqz(b,1);
title('frequency response of low pass filter design using hamming
window');
figure(2)
```

```
impz(b,1);
title('impulse response of low pass filter design using hamming
window');
```

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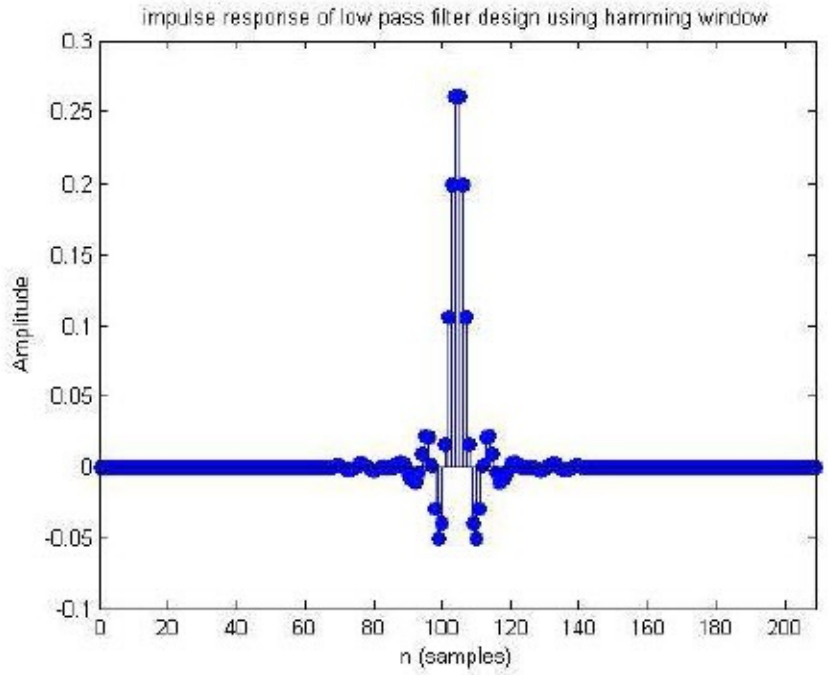
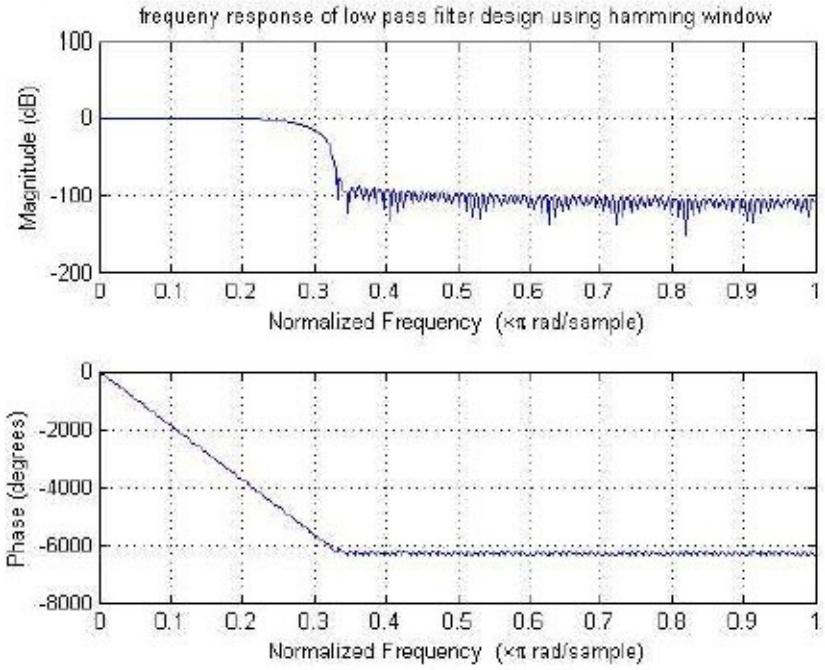
Simulations

IMPULSE RESPONSE OF THE DESIGNED FILTER (MAGNITUDE RESPONSE IN DB)



FREQUENCY RESPONSE OF THE DESIGNED FILTER (MAGNITUDE RESPONSE IN DB)



References

A. V. Oppenheim, R. W. Schafer with J. R. Buck, “Discrete-Time Signal Processing,” Second Ed., Prentice Hall Signal Processing Series, 1999. Pages 1-870

J. G. Proakis and D. G. Manolakis, “Digital Signal Processing Principles, Algorithms, and Applications,“ Third Ed., Prentice Hall, 1996. Pages 1-1016

S. K. Mitra, “ Digital Signal Processing – A Computer-Based Approach,“ Second Ed., McGraw Hill 2001 (comes with Digital Signal Processing Using MatlabR, Prentice Hall, 1999) Pages 1-354

R. A. Haddad and T. W. Parsons, “Digital Signal Processing – Theory, Applications, and Hardware,“ Computer Science Press, 1991. Pages 1-636

Joyce Van de Vegte, “ Fundamentals of Digital Signal Processing,“ Prentice Hall 2002. Pages 1-810

N. Dahnoun, “Digital Signal Processing Implementation using the TMS320C6000TM DSP Platform,“ First Ed., Prentice Hall 2000. Pages 1-234

A. V. Oppenheim, R. W. Schafer, “Digital Signal Processing,“ First Edition, Prentice Hall, 1975. Pages 1-784

Hykin, “Adaptive Filter Theory”, Prentice Hall, Fourth Edition, 2001, Pages 1-936

http://www.mathworks.com/