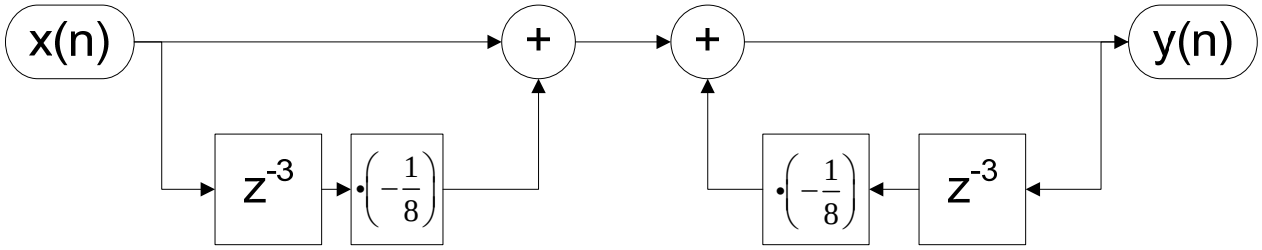
Multimedia Signal Processing 1st Module

3 /7/2013

Ex.1 (Pt.12)

A filter follows this scheme:

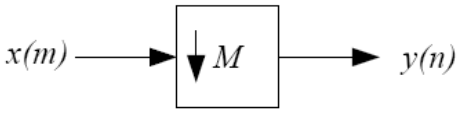


1. Define its z-transform between input and output.
2. Is it stable or not? Is it a maximum or a minimum phase filter?
3. Plot its zero-poles diagram.
4. Provide an approximate plot of its amplitude over the range of normalized frequencies.

Ex.2 (Pt.10)

Describe the downsampling of an order of 5 of a signal: (where M=5).

1. If the spectrum of original signal extends from -π/4 to π/4 (in normalized frequencies) draw the final spectrum after downsampling (quoting both axes and indicating central frequencies for all the replicas)
2. If aliasing is present in the downsampled signal, suggest a way to avoid it (keeping the same downsampling rate).



Ex.3 (Pt. 11 – MATLAB code)

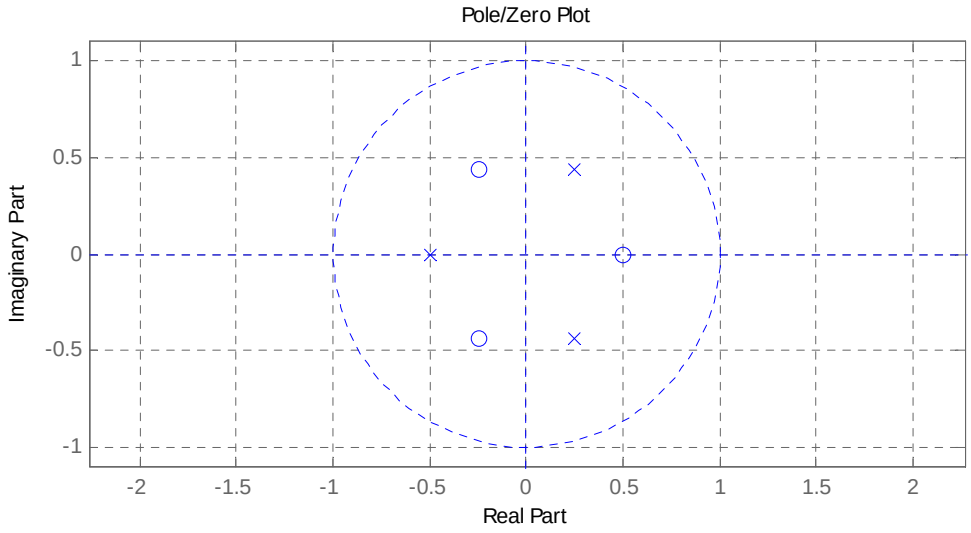
a) Build a signal sum of three different sinusoids sin(2πft) at the radian frequencies w1= π/8, w2=π/10 w3= π/3. The signal is defined over a temporal axis of 512 samples. (Assume that the sampling period T=1).
b) Upsample the signal by a factor L=4.
c) Interpolate the signal by a factor L=4 using the Matlab function 'fir1' for designing the filter, but not the function 'interp'.
d) Plot original, uplsampled and interpolated signals in the time and in the frequency domain (only modula).

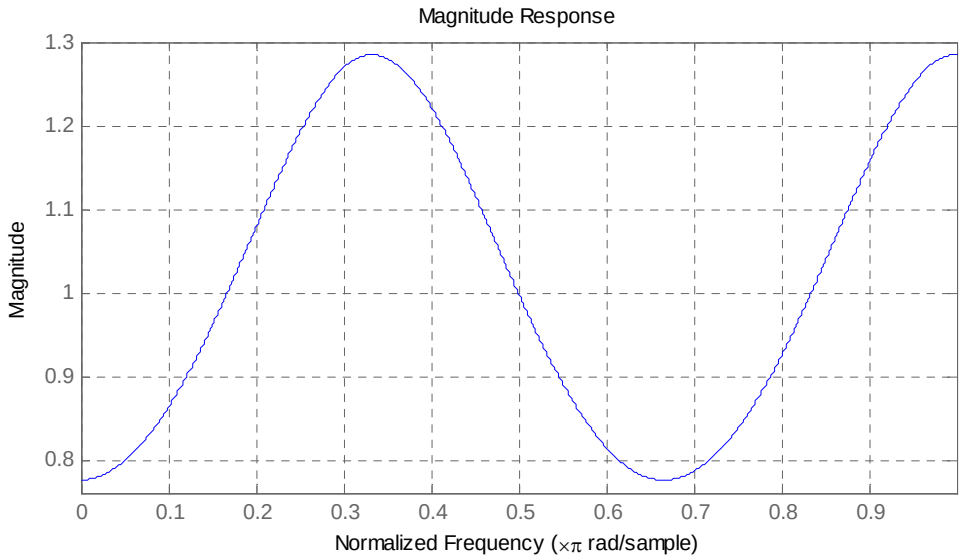
Solutions

Ex.1

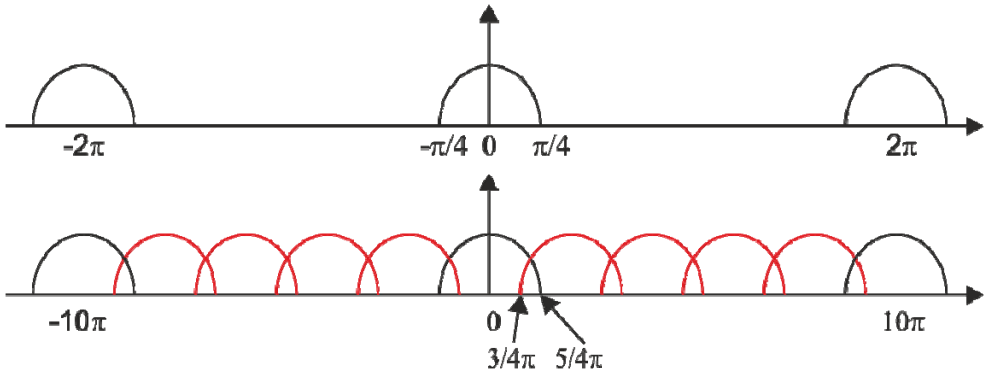
$$X(z)\left(1-\frac{z^{-3}}{8}\right)=Y(z)\left(1+\frac{z^{-3}}{8}\right)$$

The filter is stable and with minimum phase since all poles and zeros are inside the unit circle.





Ex.2



After downsampling there will be aliasing and a low pass filter at $\pi / 5$ is required.

Ex. 3

```
clc
clear all
close all

Nfft=1024;
N=41;
M=4;
fc=1/(2*M)

h = fir1(N,2*fc) ;

w1=pi/8;
w2=pi/10;
w3=pi/3;
n=[0:512];
x = sin(w1*n)+sin(w2*n)+sin(w3*n);

xup = zeros(M*length(x), 1);
xup(1:M:end ) = x ;

xint = filter(M*h, 1, xup);

figure,
subplot(3,1,1), plot(x)
subplot(3,1,2), plot(xup)
subplot(3,1,3), plot(xint)


[H, w] = freqz(x,1,1024);
[Hup, w] = freqz(xup,1,1024);
[Hint, w] = freqz(xint,1,1024);

figure,
w=2*pi*[0:Nfft-1]./Nfft;
subplot(3,1,1), plot(w, 10*log10(abs(H).^2))
subplot(3,1,2), plot(w, 10*log10(abs(Hup).^2), 'g-.');
subplot(3,1,3), plot(w, 10*log10(abs(Hint).^2), 'r--');
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