Example 8-2: Notch Filter Design I.

Purpose:

Signal $x(t) = \sin(250\pi t) + \sin(400\pi t)$ is the sum of two sinusoids, one at $f_1 = 125$ Hz and another at $f_2 = 200$ Hz. The signal is sampled by a digital signal processing (DSP) system at 1000 samples per second. Design a notch filter with $a = 0.9$ to reject the 200-Hz sinusoid, compare the input and output signals, and plot the filter's magnitude frequency response.

Inputs:

f1 and f2 are the two frequencies in Hz.
f2 is the frequency to be rejected, in Hz.
fs=sampling rate in samples/s.
aa=a=radius of poles.

Output:

Original (left) and filtered (right) signals.
Two-sided gain (left) and pole-zero diagram.

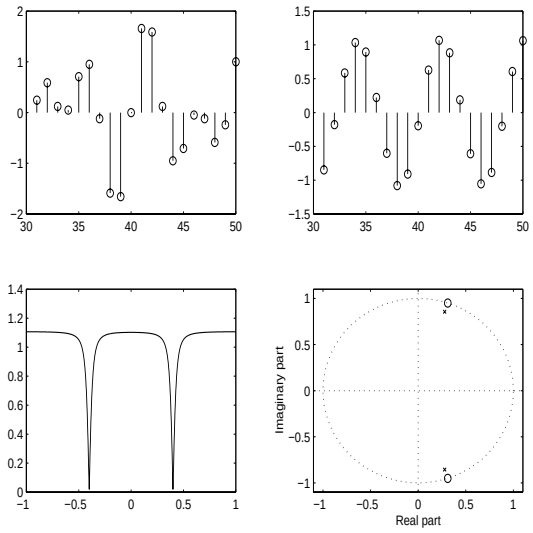

Figure 1: Simple notch filter.

Comments:

- It is clear that only one sinusoid remains.
- Duration of the transient response is 30.

Program:

```
f1=125;f2=200;fs=1000;aa=0.9;
N=1:50;%Computation interval
M=[31:50];%Display interval
W1=2*pi*f1/fs;W2=2*pi*f2/fs;
X=sin(W1*N)+sin(W2*N);
B=[1 -2*cos(W2) 1];
A=[1 -2*aa*cos(W2) aa*aa];
Y=filter(B,A,X);
subplot(221),stem(M,X(M))
subplot(222),stem(M,Y(M))
W=linspace(-1,1,1000);
Z=exp(j*pi*W);
H=polyval(B,Z)./polyval(A,Z);
subplot(223),plot(W,abs(H))
subplot(224),zplane(B,A)
```