

- 5.46 A *comb filter* (see Chapter 8) is a filter that extracts a set of isolated equally-spaced frequencies from a signal. Consider the following comb filter that has n *teeth*.

$$H(z) = \frac{b_0}{1 - r^n z^{-n}}$$

Here the filter gain is $b_0 = 1 - r^n$. Suppose $n = 10$, $r = 0.98$, and $f_s = 300$ Hz. Write a MATLAB script that uses `f_freqz` to compute the frequency response using a direct form realization. Compute both the unquantized frequency response (set `bits = []`), and the frequency response with coefficient quantization using 4 bits. Plot both magnitude responses on a single plot using the linear scale and a legend.

Solution

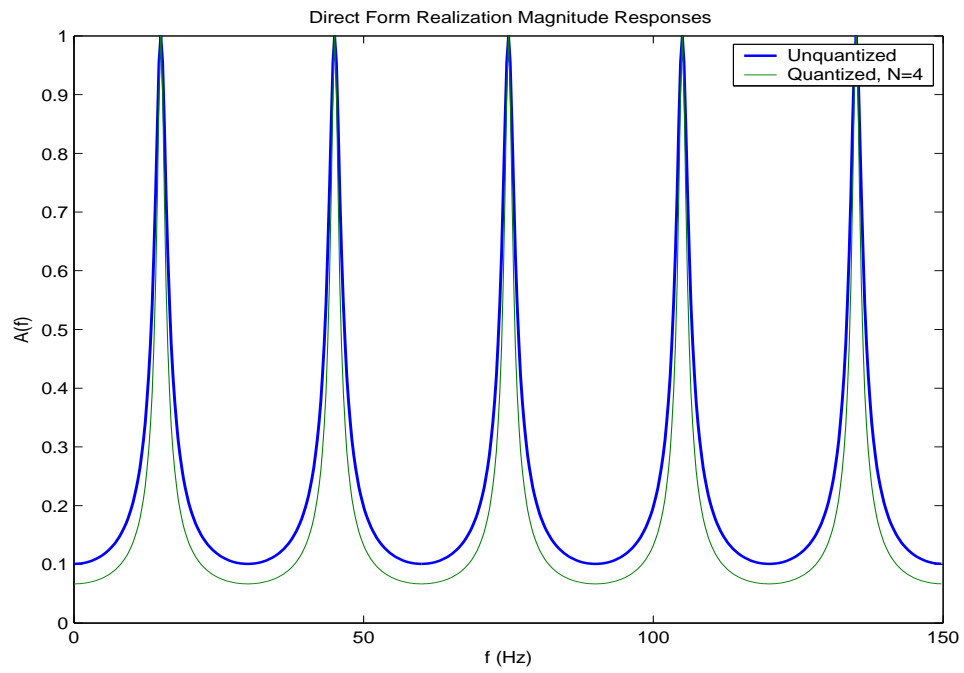
```
% Problem 5.46

% Initialize

clear
clc
n = f_prompt('Enter filter order',0,50,10);
bits = f_prompt('Enter number of bits',1,64,4);
r = 0.98;
b = 1 - r^n
a = [1,zeros(1,n-1),r^n]
fs = 300;
realize = 0;

% Compare original and quantized magnitude responses

p = 500;
[H,f] = f_freqz (b,a,p,fs,[],realize);
[H_q,f] = f_freqz (b,a,p,fs,bits,realize);
A = abs(H);
A_q = abs(H_q);
figure
h1 = plot (f,A,f,A_q);
set (h1(1),'LineWidth',1.5)
f_labels ('Direct Form Realization Magnitude Responses','f (Hz)','A(f) (dB)')
s = sprintf ('Quantized, N=%d',bits);
legend ('Unquantized',s)
f_wait
```



Direct Form Magnitude Responses of Comb Filter