PROBLEM:

The following MATLAB code will compute a time response and the frequency response of a digital filter:

```
bb = [ 1 ];    aa = [ 1   0.5 ];
xn = [ ones(1,3), zeros(1,5) ];
yn = filter( bb, aa, xn );
subplot(2,1,1), stem( [0:7], yn );   %--- TIME RESPONSE
w = -pi : (pi/100) : pi;
H = freqz( bb, aa, w );
subplot(2,1,2), plot( w, abs(H) )     %--- FREQUENCY RESPONSE
```

(a) Make the plot of `yn` that will be done by the MATLAB `stem` function (in line #4).

(b) Again referring to the MATLAB code above, make the plot of the magnitude response versus $\hat{\omega}$ over the range $-\pi \leq \hat{\omega} \leq \pi$. Justify by giving a simple formula for the frequency response $H(e^{j\hat{\omega}})$.

McClellan, Schafer and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.

SOLUTION

The following MATLAB code will compute a time response and the frequency response of a digital filter:

```
bb = [ 1 ];     aa = [ 1   0.5 ];
xn = [ ones(1,3), zeros(1,5) ];
yn = filter( bb, aa, xn );
subplot(2,1,1), stem( [0:7], yn );   %--- TIME RESPONSE
%
w = -pi : (pi/100) : pi;
H = freqz( bb, aa, w );
subplot(2,1,2), plot( w, abs(H) )     %--- FREQUENCY RESPONSE
```

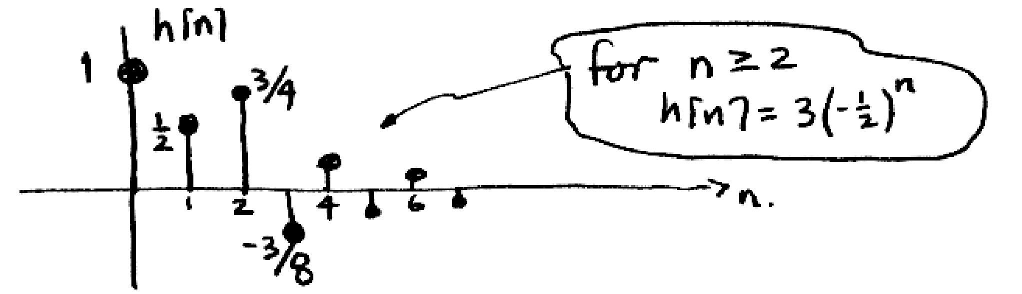
$\longrightarrow H(z) = \dfrac{1}{1+\frac{1}{2}z^{-1}}$

(a) Make the plot of yn that will be done by the MATLAB `stem` function (in line #4).

$y[n] = -\frac{1}{2}y[n-1] + x[n]$

Make table.

n	<0	0	1	2	3	4	5	6	7	
x[n]	0	1	1	1	0	0	0	0	0	
y[n]	0	1	1/2	3/4	-3/8	3/16	-3/32	3/64	-3/128	....



(b) Again referring to the MATLAB code above, make the plot of the magnitude response versus $\hat{\omega}$ over the range $-\pi \le \hat{\omega} \le \pi$. Justify by giving a simple formula for the frequency response $H(e^{j\hat{\omega}})$.

$H(e^{j\hat{\omega}}) = \dfrac{1}{1+\frac{1}{2}e^{-j\hat{\omega}}}$

at $\hat{\omega}=0$, $H(e^{j\hat{\omega}}) = \dfrac{1}{1+\frac{1}{2}} = \dfrac{2}{3}$

at $\hat{\omega}=\pi$, $H(e^{j\hat{\omega}}) = \dfrac{1}{1-\frac{1}{2}} = 2$.

pole at $z = -1/2$

$\Rightarrow$ High-pass