$\boxed{8.43}$ Write a MATLAB script that uses *f_butters* and *f_bilin* to find the digital equivalent, $H(z)$, of a sixth order lowpass Butterworth filter using the bilinear transformation method. Suppose the sampling frequency is $f_s = 10$ Hz. Prewarp the analog cutoff frequency so that the digital cutoff frequency comes out to be $F_c = 1$ Hz.

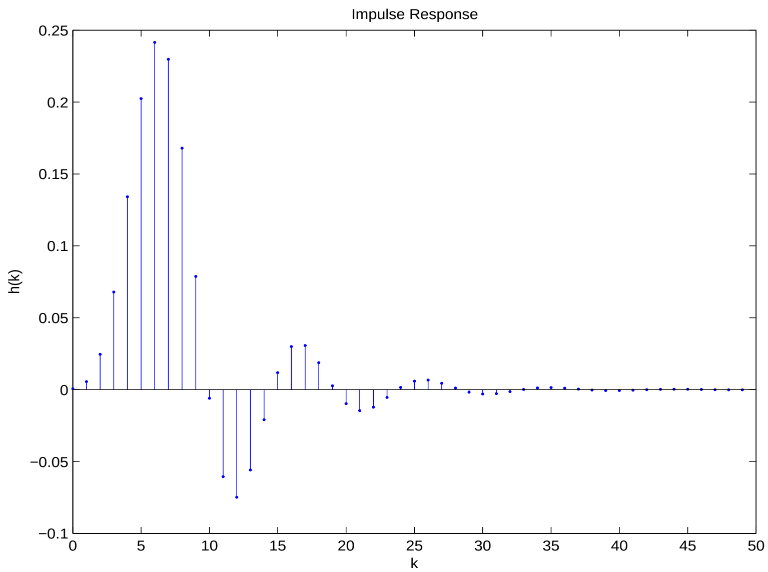
(a) Plot the impulse response, $h(k)$.

(b) Use *f_pzplot* to plot the poles and zeros of $H(z)$.

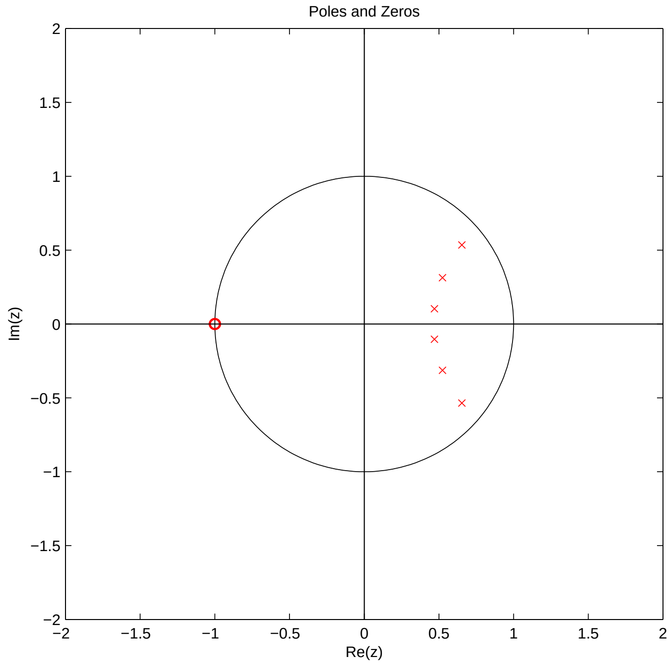
(c) Use *f_freqz* to compute and plot the magnitude response, $A(f)$. Add the ideal magnitude response and a plot legend.

```
% Problem 8.43

% Initialize

clear
clc
n = 6;
fs = 10;
T = 1/fs;
f_c = 1;

% Prewarp cutoff frequency

F_c = tan(pi*f_c*T) / (pi*T)

% Compute Butterworth lowpass filter

[B,A] = f_butters (F_c,2*F_c,0.1,0.1,n);

% Apply binlinear transformation

[b,a] = f_bilin (B,A,fs);

% Plot impulse response

N = 50;
h = f_impulse (b,a,N);
k = 0 : N-1;
figure
stem (k,h,'filled','.')
f_labels ('Impulse Response','k','h(k)')
f_wait

% Plot poles and zeros

f_pzplot (b,a,'Poles and Zeros')
f_wait

% Plot magnitude response
```

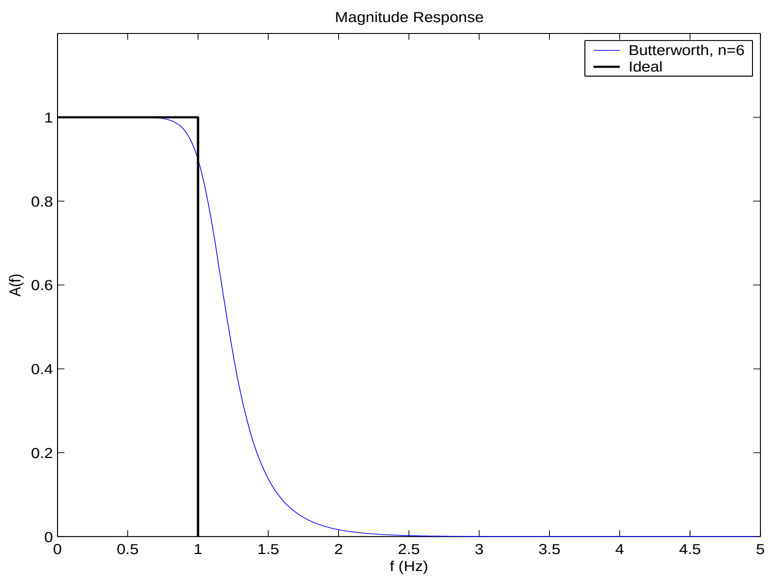
```
p = 200;
[H,f] = f_freqz (b,a,p,fs);
A = abs(H);
figure
plot (f,A)
f_labels ('Magnitude Response','f (Hz)','A(f)')

% Add ideal response

hold on
plot ([0 f_c f_c],[1 1 0],'k','LineWidth',1.5)
axis ([0 fs/2 0 1.2])
legend ('Butterworth, n=6','Ideal')
f_wait
```



Butterworth Impulse Response



Butterwoth Poles and Zeros



Butterworth Magnitude Response