Example 8-1: Half-Band Lowpass Filter.

Purpose:

A half-band lowpass filter passes discrete-time signals with angular frequencies below $\pi/2$ and rejects signals with angular frequencies above $\pi/2$. For such a filter with

- **Zeros:** $\{e^{\pm j\pi/2}, e^{\pm j3\pi/4}, e^{j\pi}\}$,
- **Poles:** $\{0.6, 0.8e^{\pm j\pi/4}, 0.8e^{\pm j\pi/2}\}$,

(a) obtain its $\mathbf{H}(\mathbf{z})$, (b) its difference equation, and (c) generate a plot of its magnitude spectrum $M(e^{j\Omega})$. Assume $C = 1$.

Outputs:

One-sided gain and pole-zero diagram.
(a) and (b) are solved in the text.

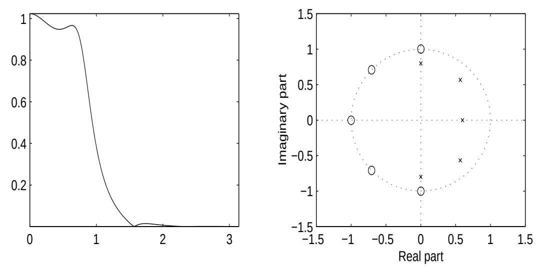

Figure 1: One-sided gain (left) and pole-zero diagram (right) for half-band filter.

Comments:

A pole at 0.6 gives better response than a pole at 0.8 does, so we use 0.6 here.

Program:

```
clear;Z=exp(j*pi*[2:6]/4);
P=0.8*exp(j*pi*[1 2 -1 -2]/4);
P=[P 0.6];W=linspace(0,pi,1000);
B=poly(Z);A=poly(P);Z1=exp(j*W);
H=polyval(B,Z1)./polyval(A,Z1);
H=H/H(1);%Normalize dc gain to 1.
subplot(221),plot(W,abs(H))
subplot(222),zplane(B,A)
axis([-1.5 1.5 -1.5 1.5])
```