4.15 An LTI system is characterized by the following z-transform:

$$\frac{1+z^{-2}}{1+0.81z^{-2}}$$

Determine the frequency response at dc, 1/4 and 1/2 the sampling frequency. Sketch the frequency response in the interval $0 \leq \omega \leq \omega_s$, where ω_s is the sampling frequency in rad s^{-1}.

At DC $\quad z = re^{j\phi} = 1 \qquad$ DC $\rightarrow \phi = 0$

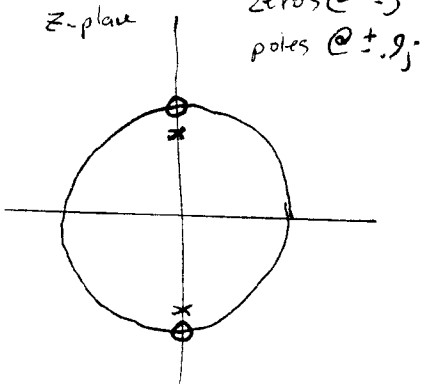
$$H(z=1) = \frac{1+(1)^{-2}}{1+0.81(1)^{-2}} = \frac{2}{1.81} = \boxed{1.1}$$

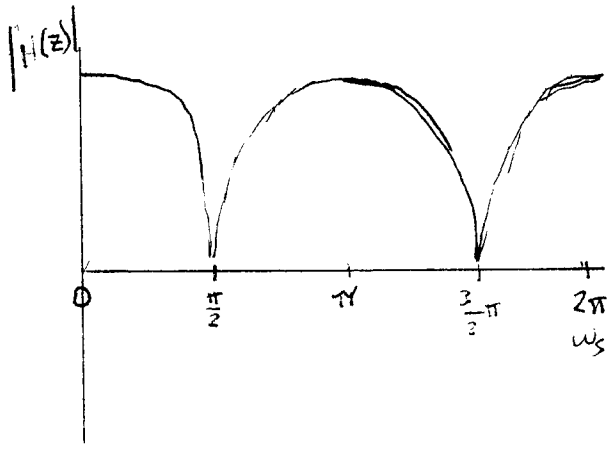
At $\frac{1}{4} F_s$ $\quad z = e^{j\frac{\pi}{2}} = +j$

$$H(z=j) = \frac{1+(j)^{-2}}{1+0.81(j)^{-2}} = \frac{1-1}{1-0.81} = \boxed{0}$$

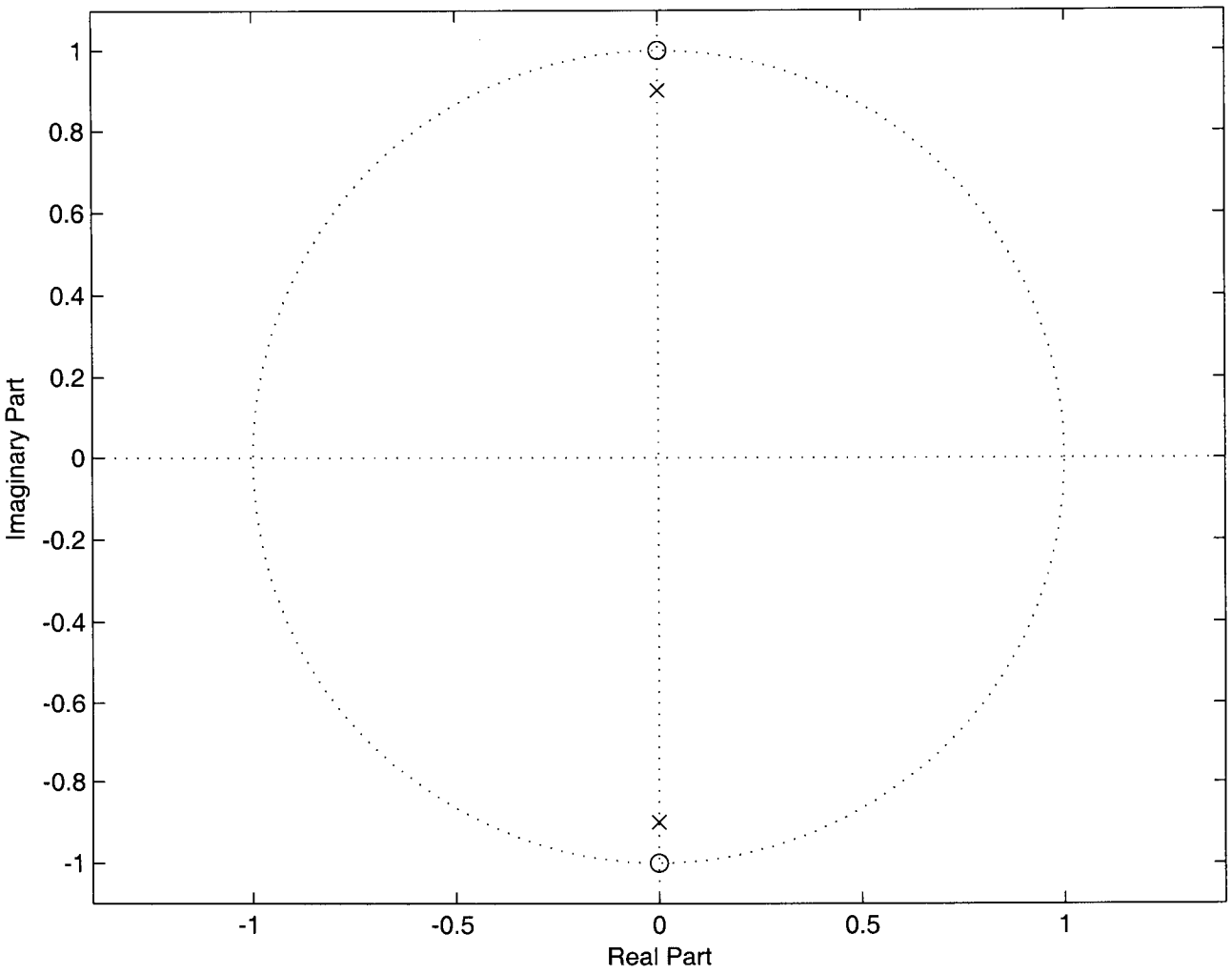
At $\frac{1}{2} F_s$ $\quad z = e^{j\pi} = -1$

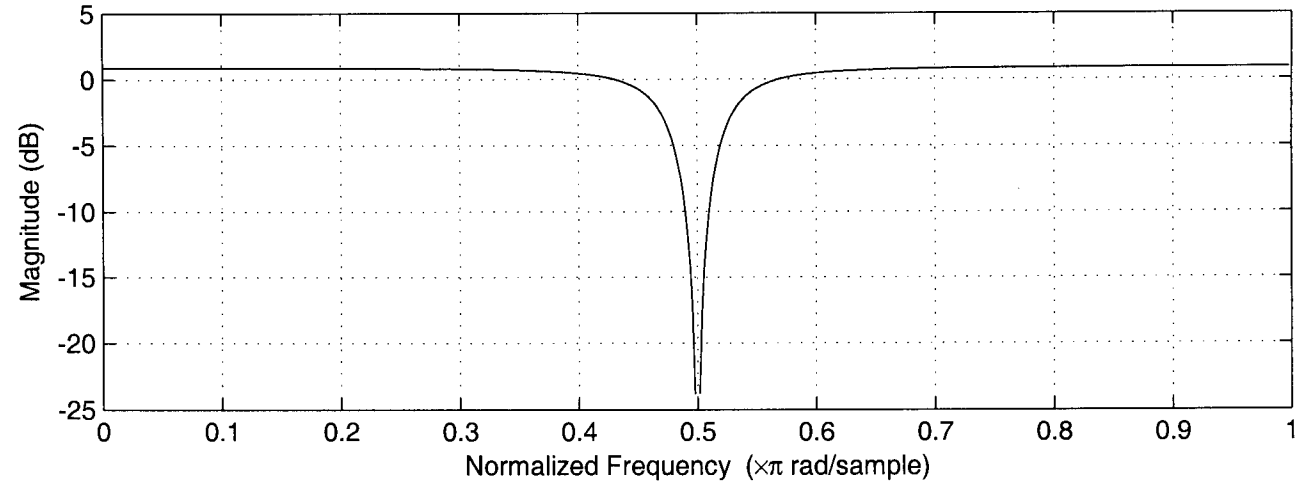
$$H(z=-1) = \frac{1+(-1)^{-2}}{1+0.81(-1)^{-2}} = \boxed{1.1}$$

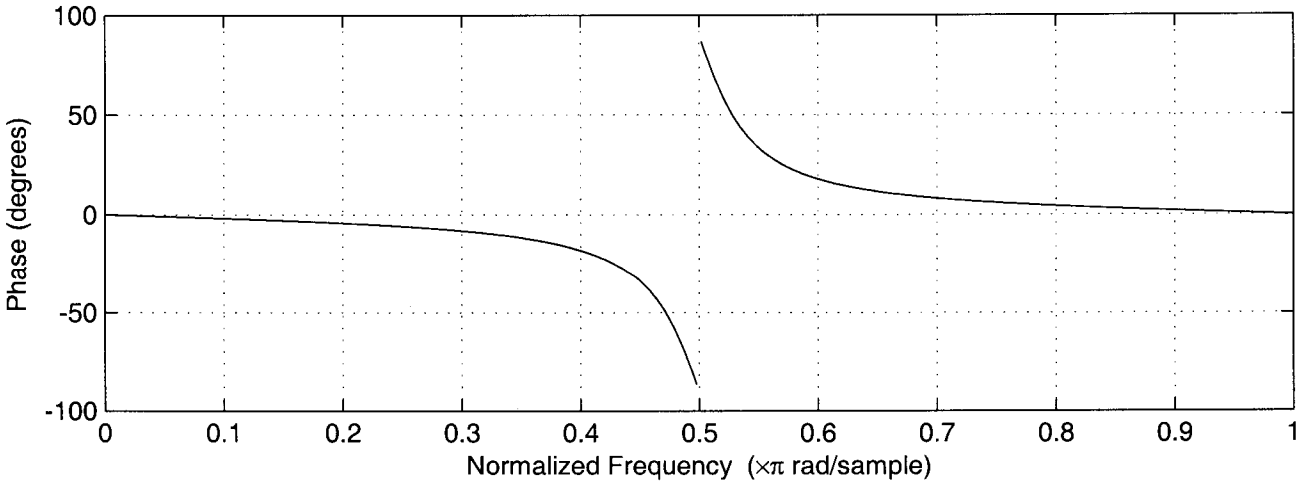




see following MATLAB PLOTS


1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Imaginary Part
-1
-0.5
0
0.5
1
Real Part


5
0
-5
-10
-15
-20
-25
Magnitude (dB)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Frequency (×π rad/sample)


100
50
0
-50
-100
Phase (degrees)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Normalized Frequency (×π rad/sample)