Assignment - 8
Inverse Systems

April 6, 2018

Task 1

Consider a system $H(z)$ which has the following poles and zeros:

1. 4 poles at $z = 0$.
2. 4 zeros at $z = 0.9e^{j0.6\pi}, 0.9e^{-j0.6\pi}, 1.25e^{j0.8\pi}, 1.25e^{-j0.8\pi}$.

Consider a signal $x[n]$

$$x[n] = \text{sinc}\left(\frac{\pi}{16}(n-50)\right)\cos(\omega_c * n).$$

1. Draw the magnitude, phase and group delay response of the system using MATLAB. Do not use MATLAB's builtin functions.
2. Is the system stable? Is the system causal?
3. Pass $x[n]$ through $H(z)$ for $\omega_c = 0.1\pi, 0.2\pi, 0.4\pi, 0.8\pi$ and obtain the output signal $y[n]$. How the magnitude of the output signal changes with change in ω_c? Can you explain the difference in magnitude corresponding to different ω_c using the magnitude response of $H(z)$.
4. Design a causal, stable magnitude inverse of the system. Pass all $y[n]$ obtained in the previous part through the the inverse system? What is the maximum magnitude of the output of the inverse system? Can you explain the different maximum magnitudes of the output signals corresponding to different ω_c? Draw magnitude, phase and group delay response of the inverse sytem. Do you think you have gotten exactly the same $x[n]$ at the output of the inverse system? Why or why not?
5. What is the magnitude, phase, group delay of the overall system, i.e., $H(z)$ cascaded with its magnitude inverse.

6. How much delay do you observe corresponding to different ω_c? Can you explain the delay in the output to the group delay of the overall system ($H(z)$ cascaded with its inverse).

Hint: Read frequency response compensation section in Chapter 5.