

# Assignment - 7

## Transform Analysis of LTI Systems

June 14, 2021

### Task 1

Consider the following LTI system:

$$H(z) = \frac{(z^{-1} - 0.9e^{-j0.2\pi})(z^{-1} - 0.9e^{j0.2\pi})}{(1 - 0.9e^{j0.2\pi}z^{-1})(1 - 0.9e^{-j0.2\pi}z^{-1})}.$$

Also, consider the following input  $x[n]$ :

$$x[n] = \text{sinc}\left(\frac{\pi(n-30)}{16}\right) \cos(\omega_0 n), 0 \leq n \leq 60.$$

### Questions

1. Plot the magnitude response, phase response (unwrapped), phase response (principal value) and group delay of the system. For group delay, it is already known that a close approximation to the derivative of a signal is using the following scaled difference equation on its sampled version:

$$(y[nT] - y[(n-1)T])/T,$$

where  $T$  is the sampling interval of the signal. How much group delay is present for signals around frequencies  $0.2\pi, 0.4\pi, 0.9\pi$ , all in radians per sample?

2. Draw the spectrum of  $x[n]$  for  $\omega_0 = 0.2\pi, 0.4\pi, 0.9\pi$ . What is the effect of changing  $\omega_0$  on the spectrum of  $x[n]$ .
3. Pass  $x[n]$  through the system for the three values of  $\omega_0$ ? Did you see any change in the signal in the corresponding output? Do you see any change in the signal envelope at the output? Give reason for any change in the output corresponding to the three inputs.

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