# EE321 Forth Homework Assignment

**@ Kefu Xue, Ph.D., Sep. 2001 to July 2007**

## 1 Frequency Response and Sinusoidal Steady State Response

1. For a LTI system described by transfer function

$$H(s) = \frac{s^2 + s}{s^2 + 6s + 8}$$

find the steady–state system responses to the following inputs

   (a) $f_1(t) = 4$

   (b) $f_2(t) = 2\cos(12\pi t - 1)$ and plot the input signal, $f_2(t)$, and the steady state response signal, $y_{ss}(t)$, on a same plot with the same time variable, $t$, and comment on the differences of the two signals.

   (c) $f_3(t) = 1 + 0.5\sin(2t + \frac{\pi}{3})$

2. For an all pass filter described by transfer function

$$H(s) = \frac{-s + 20}{s + 20}$$

find the steady-state system response to the following inputs and calculate the relative time delay between the input and output signals.

   (a) $x_1(t) = \cos(2\pi t)$

   (b) $x_2(t) = \cos(6\pi t)$

   (c) $x_3(t) = \cos(10\pi t)$

   (d) $x_4(t) = \cos(10\pi t) + \cos(6\pi t) + \cos(2\pi t)$, plot more than two periods of $x_4(t)$ and the steady state response signal $y_{ss}(t)$ on a same plot with the same time variable, $t$, and comment on the differences of the two signals.

   (e) Plot the magnitude and phase frequency response of the filter using Matlab for frequency 0 to 20 Hz with frequency resolution of 0.1 Hz.

3. For a LTI system

$$H(s) = \frac{s^2 + 100}{s^2 + 15s + 56}$$

find the steady-state system response to the following inputs

   (a) $x(t) = 4\cos(10t - 0.4) + 2\sin(7t) - \cos(2t - 0.5)$

(b) Plot the magnitude and phase frequency response using Matlab for frequency 0 to 50 radian/second with frequency resolution of 0.1 radian/second. Verify your answer to the above question using the eigenvalues from the plots of magnitude and phase frequency responses?

4. Draw Bode plots of following LTI systems and compare with the Matlab plots of the magnitude (in dB scale) and phase (in degree) frequency responses of the same systems:

   (a) $H_1(s) = \frac{s+20}{s(s+50)}$

   (b) $H_2(s) = \frac{(s+20)}{(s+100)(s^2+16s+100)}$

   (c) $H_3(s) = \frac{s(s+10)}{(s+100)(s^2+90s+2000)}$

   (d) $H_4(s) = \frac{-s+20}{s+20}$

5. **Problems in the text book: 7.3-1 (Plot the bode plots of the three systems.)**