CHE 576 - Assignment 4

Winter 2012

Due 12:00 p.m., January 17, Friday

Q.1: Determine if the systems given by the following representations are stable:

- $G(z) = \frac{1}{z^2-1.5z+0.9}$
- $G(z) = \frac{1}{z^3-3z^2+2z-0.5}$
- $G(z) = \frac{1}{z^3-2z^2+2z-0.5}$
- $G(z) = \frac{1}{z^3-1.7z^2+1.7z-0.7}$

Q.2: Determine if the system is stable:

- $x(k+1) = Ax(k)$, $x(0) = [1 \ -1]$, where $A = \begin{bmatrix} -0.5 & 1 \\ 0 & 0.5 \end{bmatrix}$ and find values of the state vector at $n = 5$, that is $x(5)$. (Hint: use function jordan in matlab)

Q.3: The process of interest is given as two tanks system in series which is given in the picture below, Fig.1. People working in the company that regulates and monitors two tanks performed

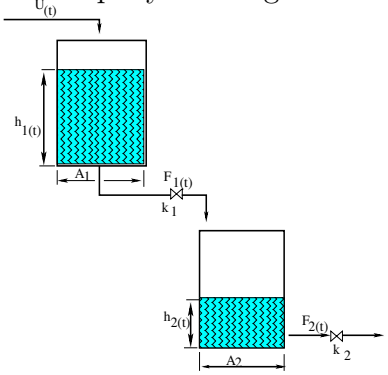

Figure 1: Two tanks model.

a series of the experimental studies to identify transfer function. They came to conclusion after using the **impulse response** of the system that transfer function that relates the input flow $u(t)$ and height in the second tank is given as $G(z) = \frac{1}{z^2-0.34z+0.024}$ which is obtained with their analysis of model and they used sampling time $1sec$.

a) The company is interested in monitoring the height in the tank 2 and they place the measuring device (red box) on the second tank which measures the height as $h(n)$, Fig.2. They are also aware that $h(n)$ changes very slow and they want to get rid off the higher frequencies in $h(t)$ signal. The function of $h(n)$ is linear combination of slow smooth signal and high frequency signal coming from the first tank. They ask you to construct a module (Filter) on the Fig.2, with the transfer function which is physically realizable such that the high frequency dynamics is blocked in the desired signal. They provide you with the signal given as sequence $\{0.21\}^n$. Construct the filter for the required signal and demonstrate that monitoring device on the figure will not contain undesired signal content.

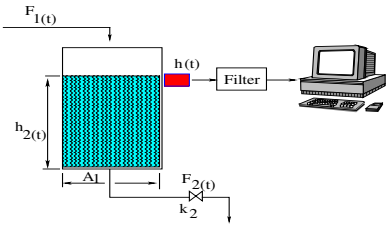

Figure 2: Tank with height signal filtering

b) Company is satisfied with your realization of the filter for the monitoring purposes, Fig.3. They did not tell you that they are going to use your filter $G_f(z)$ and their plant model $G(z)$ in the series connection for the regulation of the overall closed-loop system.

   – To find and plot for them the closed-loop system response with the filter.

   However, they claim that their regulatory system is corrupted, and they claim that if filtered signal is used for the regulatory purposes they have undesired response. They ask you:

   – They ask you if you can redesign filter such that undesired frequency oscillations are removed from the closed-loop. They ask you to ensure the closed-loop system stability and they ask you to find (plot) for them impulse response of the closed loop system.

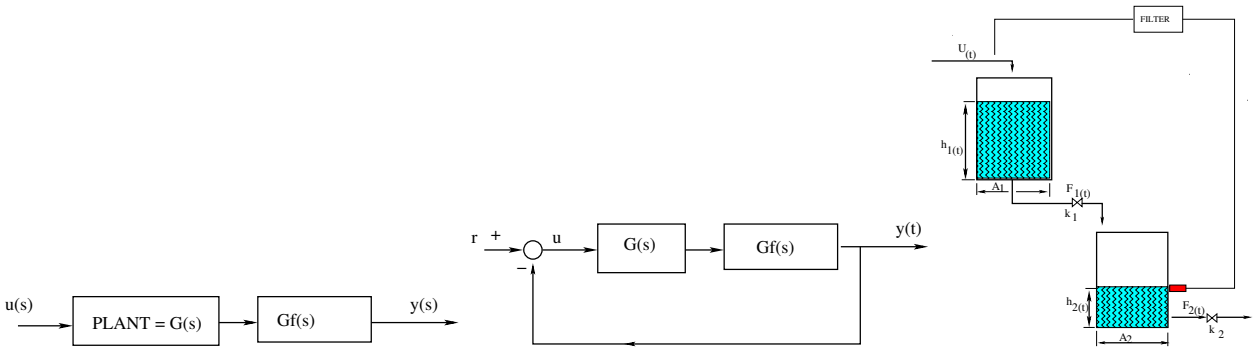

Figure 3: The open and closed-loop system representation