EEL 325 Control Engineering II

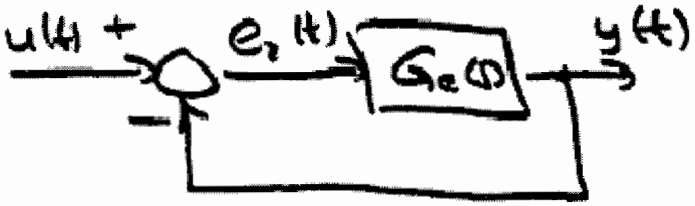
Major Exam

Total Marks 50

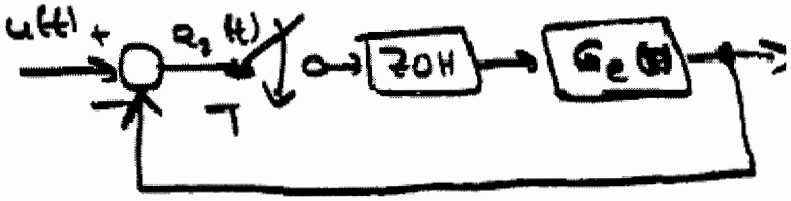
Answer all the questions

Part A.

1. Let k_c be the steady state error of the type-0 continuous system $G_e(s)$. The steady state error k_c is 5.

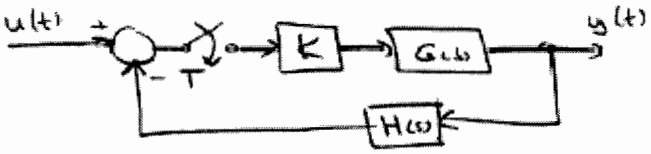


Assume the sampling time is at least 10 times smaller than rise time of $G_e(s)$. The rise time of continuous system is 4 sec. What will be the steady state error of the same system in discrete domain shown below?



(5 Marks)

2. Find K at which the discrete system is unstable using discrete Nyquist diagram.



Let H(s) = 1 and $G(s) = \dfrac{e^{-0.5s}}{s(s+1)}$ at T = 1 sec **(5 Marks)**

3. Design a digital controller for the system such that the closed-loop system is stable and satisfies the following specifications:

a. Settling time to 2% to be less than 2sec
b. Overshoot to a step input less than 6%

$$x(k+1)=\begin{bmatrix}1 & 0.1\\ 0 & 1\end{bmatrix}x(k)+\begin{bmatrix}0.005\\ 0.1\end{bmatrix}u(k)$$
$$y(k)=\begin{bmatrix}1 & 0\end{bmatrix}x(k)$$

(10 Marks)

4. For the open loop system

$$G(s)=\frac{y(s)}{u(s)}=\frac{1}{s^2+0.2s+1}$$

a) Find the discrete state-space representation assuming there is a ZOH and the sampling period T=0.5 sec.
b) Find the full state digital feedback that provides necessary specification given in the previous question.
c) ~~Examine the initial and final value of closed loop system.~~

(3+~~4~~ Marks)

5. For the open loop system

$$x(k+1)=\begin{bmatrix}1 & 1\\ 0 & 1\end{bmatrix}x(k)+\begin{bmatrix}0.5\\ 1\end{bmatrix}u(k)$$

Check the observability for:
a. H = [0 1]
b. H = [1 0]
c. Rationalize your results to a) and b), stating why the observability or lack of observability occurred.

(3+3+4 Marks)

6. A sampled data system is described by the transfer function G(s) = 1/s(2s+1). Design a digital controller D(z) to realize the following specifications
a. $K_v \geq 1$
b. Damping ration is 0.5
c. Settling time is ≤ 8 sec (2% tolerance)

(10 Marks)