Computer Controlled Systems

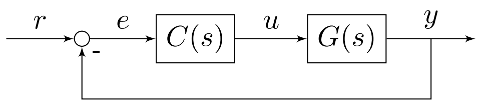
2nd midterm test

2017.12.07.

computational exercises (25 points)

(The answers can be given in Hungarian)

1. The following transfer function is given: $G(s) = \frac{s+2}{s-1}$. We want to design a PD controller with the transfer function $C(s) = K_P + sK_D$. Determine the values of K_P and K_D, such that the poles of the resulting controlled system are -1 and -5. Will the output y of the controlled system converge to any constant reference signal r? (5p)



2. Consider the following continuous-time state-space model:

$$A = \begin{pmatrix} 1 & 2 \\ 0 & -1 \end{pmatrix}, \quad B = \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \quad C = \begin{pmatrix} 2 & 1 \end{pmatrix}$$

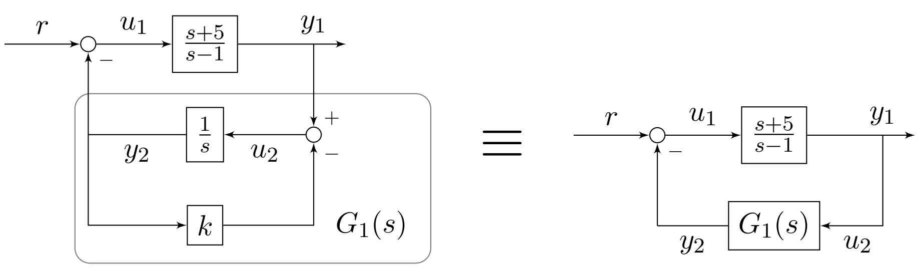
   a) Determine the model matrices Φ and Γ of the discrete time state-space model

   $$x(k+1) = \Phi x(k) + \Gamma u(k), \quad y(k) = Cx(k),$$

   if the sampling period is $h = \ln(2)$. (4p)

   b) Is the discrete-time state-space model stable? Justify your answer! (1p)

3. The following block diagram is given:



   a) Compute the resulting transfer function $G(s)$ for this block diagram. (4p)
   First of all try to determine the resulting transfer function $G_1(s)$ of the highlighted subsystem.

   b) Choose the value of k such that the poles of the resulting transfer function be -1 and -2. (1p)

4. Let us consider the following continuous time LTI system:

$$A = \begin{pmatrix} 8 & -1 \\ 1 & 6 \end{pmatrix}, \; B = \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \; C = \begin{pmatrix} 1 & 0 \end{pmatrix}$$

   a) Check the asymptotic stability of the system. (1p)

   b) Design a pole-placement controller, for which the desired characteristic polynomial is $s^2 + 14s + 49$. (4p)

   c) Check the results by recomputing the poles of closed loop. (1p)

   d) Design a state observer with the following prescribed poles: $-2, -2$. (4p)