Computer Controlled Systems

replacement test – 2017. 12. 20.

(The answers can be given in Hungarian)

Theoretical questions (25 points)

1. Describe the conditions, that a continuous-time Lyapunov function has to satisfy. (You do not need to state the Lyapunov theorem.) (5p)
2. When do we call an LTI system BIBO stable? What is the necessary and sufficient condition for BIBO stability? (5p)
3. Briefly describe PID control (controller structure, transfer function, parameters, block scheme of the whole PID control loop). (5p)
4. Describe the problem statement of pole placement control design. (i.e., what are the known data and what is to be computed?). What kind of feedback is obtained? (5p)
5. When do we call a state space model (A, B, C) observable? What is the necessary and sufficient condition for observability? (5p)

Computational exercises (25 points)

1. Consider the state space model $\begin{cases} \dot{x} = Ax + Bu, \\ y = Cx, \end{cases}$ with $A = \begin{pmatrix} -2 & 1 \\ 0 & -1 \end{pmatrix}$, $B = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$, $C = \begin{pmatrix} 1 & 1 \end{pmatrix}$.
   (a) Give the transfer function $H(s)$ for the system. (3p)
   (b) Is the system asymptotically stable? Is the system observable? (1+1p)
2. Design a stabilizing state feedback gain (K), which moves the poles of the state space model (A, B, C) into (-1, -4), where (5p)
$$A = \begin{pmatrix} -2 & 1 \\ -1 & 0 \end{pmatrix}, \quad B = \begin{pmatrix} 2 \\ 1 \end{pmatrix}, \quad C = \begin{pmatrix} 0 & 1 \end{pmatrix}$$
3. Consider the following continuous-time state space model:
$$A = \begin{pmatrix} -1 & 1 \\ 0 & -2 \end{pmatrix}, \quad B = \begin{pmatrix} 1 \\ 3 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & -1 \end{pmatrix}$$
   Determine the model matrices Φ and Γ of the discretized state-space model
$$x(k+1) = \Phi x(k) + \Gamma u(k), \quad y(k) = Cx(k),$$
   if the sampling period is $h = \ln(2)$. (5p)
4. Give the controller form state space realization of the following system given with its transfer function (3p)
$$H(s) = \frac{s^2 + 1}{s^4 + s^2 + 3}$$
   Is the obtained controller form state space realization minimal? (2p)
5. Determine the overall transfer function of the following block diagram! (5p)