Computer Controlled Systems

1st midterm test

2018. 10. 25.

theoretical questions (25 points)

(The answers can be given in Hungarian)

1. Fundamental system properties

    (a) Define the notion of a *linear system.* (3p)

    (b) Is the following system model *time invariant*? Why? (3p)

    $$\dot{x}(t) = -x^3(t) + \cos(t)u(t) \tag{1}$$
    $$y(t) = 0.5x(t), \tag{2}$$

    where t is the independent time variable, u is the input, y is the output, and x is the state variable.

2. How can we compute the impulse response function (h) of a system given in the form of a state space model with matrices A, B and C? What is the explicit form of $h(t)$? (We assume that $D = 0$.) (4+2p)

3. Consider the following state-space model

    $$\dot{x} = \begin{bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u \tag{3}$$

    $$y = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} x \tag{4}$$

    where $\lambda_i \in \mathbb{R}$ for $i = 1, 2, 3$

    (a) Give a base of the controllability subspace of the system. (4p)

    (b) How can we select λ_1, λ_2 and λ_3 such that the dimension of the controllability subspace is 1? (2p)

4. Give the controller form realization of the following transfer function model:

    $$H(s) = \frac{s^2 - 1}{(s + 2)(s - 2)(s + 3)} \tag{5}$$

    Is the computed realization observable? Why? (4+3p)