Control Systems Course, Academic Year 2013-2014

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Second Exam Session, Part 1. February 12^{th} 2014

Available time: 2 h

Ex1 (11 points) Given a plant characterized by the transfer function

$$G(s) = \frac{(s+3)(s+4)}{s(s+1)^2},$$

compute the output signal $y(t)$ of the plant to the signal $u(t) = (3 + t^2 - sin2t)\delta_{-1}(t)$ applied to the input of the plant, and assuming zero initial conditions. Then design a control scheme and characterize the set of parameters of a controller $G_c(s) = \frac{K(s+z)}{s^\alpha(s+p)}$, $K \in \mathbb{R}$, $z, p > 0$, $\alpha \geq 0$ a non-negative integer, such that the following hold:

1. the closed loop system is astatic with respect to a step additive disturbance applied to the output of the plant;
2. the steady state error with respect to a parabola input is smaller or equal to 10^{-1};
3. all poles of the closed loop system have real part smaller or equal to -2.

Ex2 (11 points) Given an actuator characterized by the following state space representation

$$\begin{aligned} \dot{x}_1(t) &= x_1(t) + x_2(t) - u(t), \\ \dot{x}_2(t) &= -x_1(t) + 2x_2(t) - u(t), \\ y(t) &= x_1(t) - 2x_2(t), \quad t \geq 0. \end{aligned}$$

and a plant characterized by the transfer function $G(s) = \frac{s+1}{s-3}$, design a control scheme and characterize the set of parameters of a controller $G_c(s) = \frac{K_P + K_D s}{s^\alpha}$, $K_P, K_D \in \mathbb{R}$, $\alpha \geq 0$ a non-negative integer, such that:

1. the closed loop system is astatic with respect to a step additive disturbance applied to the output of the plant;
2. the steady state error with respect to a ramp input is smaller than 0.1;
3. the settling time of the closed loop system is smaller than $1s$.

Finally discuss the implementability of the obtained controller.

Ex3 (8 points) Discuss the rejection with respect to polynomial disturbances applied to the input of a plant, to the output of a plant and to the feedback branch.