Control Systems Course, Academic Year 2013-2014

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Mid Term Exam, November 28^{th} 2013

Available time: 2 h

Ex1 Given a plant characterized by the transfer function

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

compute the response $y(t)$ to the reference input $u(t) = (3 - \sin 2t)\delta_{-1}(t)$ applied directly to the plant. Then design a control scheme and and characterize the set of parameters of a controller $G_c(s) = \frac{K(s+z)}{s^\alpha(s+p)}$, $K \in \mathbb{R}$, $z, p > 0$, α 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 input of the plant $G(s)$;
2. the steady state error with respect to a ramp input is smaller or equal to 10^{-2};
3. All poles of the closed loop system have real part smaller or equal to -1.

Ex2 Given an actuator A characterized by the following state space representation

$$\begin{aligned} \dot{x}_1(t) &= 2x_1(t) + 4x_2(t) + u(t), \\ \dot{x}_2(t) &= x_1(t) + 2x_2(t), \\ y(t) &= x_1(t), \quad t \geq 0. \end{aligned}$$

and a plant G characterized by the transfer function $G(s) = \frac{1}{s-2}$, design a control scheme and characterize the set of parameters of a controller $G_c(s) = \frac{K_P + K_D s}{s^\alpha}$, $K_P, K_D \in \mathbb{R}$, α a non-negative integer, such that:

1. the closed loop system is astatic with respect to a step additive disturbance applied between the actuator and the plant;
2. the steady state error with respect to a ramp input is smaller than 0.1.

Discuss the steady state behavior of the system with respect to polynomial additive disturbances applied to the input of the actuator.

Ex3 Discuss the type number of a feedback control system and provide some illustrative examples.