**Control Systems Course, Academic Year 2013-2014**

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**First Exam Session, Part 1. January** $29^{th}$ 2014

Available time: 2 h

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

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

compute the output signal $y(t)$ of the plant to the signal $u(t) = (3+t)\delta_{-1}(t)$ 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 ramp input is smaller or equal to $10^{-2}$.

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

$$\begin{aligned} \dot{x}_1(t) &= 3x_1(t) + 2x_2(t), \\ \dot{x}_2(t) &= -x_1(t) + u(t), \\ y(t) &= x_1(t), \quad t \geq 0. \end{aligned}$$

and a plant characterized by the transfer function $G(s) = \frac{s+2}{s}$, 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 step input is smaller than 0.1;
3. all poles of the closed loop system have real part smaller or equal to -1.

Finally discuss the implementability of the obtained controller.

**Ex3** (8 points) Discuss the design specifications on the transient response of a feedback control system, and provide one illustrative example.