Master of science degree in Mechatronic Engineering
Academic Year 2016-2017, First Semester

Laboratory of Robust Identification and Control (01PDXOV-01PDXQW-01PDXND)

Diego Regruto

Exam Simulation No. 1

Surname	**Name**
Student ID	

The student is required to derive mathematical model of a plant $G_p(s)$ according to the procedure described below.

(A) **5 Points** — Formulate the problem of identifying the mathematical model of the plant in the set-membership framework, on the basis of the following information:

- the plant can be modeled by a discrete-time linear time-invariant systems described by the following transfer function

$$G(z) = \frac{\beta_1 z + \beta_2}{z^2 + \alpha_1 z + \alpha_2}.$$

- A set of 100 input-output data pair (available in the data file *sim_exam_ex3_data*) has been collected to describe the input-output behavior of the plant.
- The input sequence is assumed to be exactly known, while the output data are known to be corrupted by an additive noise $\eta(t)$ having absolute value of amplitude bounded by $\Delta_\eta = 0.05$.
- Input-output data have been collected with a sampling time $T_s = 10^{-3}$s.

[Hint: expected output of this stage is a mathematical formal definition of the key ingredients of the set-membership identification problem to be solved (Feasible Set, Extended Feasible Set, Parameter Uncertainty Intervals)]

(B) **3 Points** — Provide a mathematical formulation of the optimization problems to be solved for the computation of the PUIs. [Hint: expected output of this stage are the mathematical equations that described the optimization problem to be solved for computing the PUIs. provide also comments on the main characteristics of such optimization problems (class of optimization problems, convexity/nonconvexity, relaxations,software to be used for solving the problem)].

(C) **7 Points** — Provide a accurate description of the data structure to be built in order to solve the problem with the sparsePOP software. [Hint: expected outputs of this stage are detailed information about the structure of the matrix *support* and the array *coef*]

(D) **7 Points** — Write a MATLAB script for the computation of the PUIs. [Hint: expected outputs of this stage are the MATLAB script, the obtained PUIs and the discrete-time nominal model provided by the central estimate].

(E) **4 Points** — Using the information obtained from the identification stage, build a continuous-time unstructured multiplicative uncertainty model of the form

$$G_p(s) = G_{p_n}(1 + W_u\Delta),\ \|\Delta\|_\infty \leq 1 \tag{1}$$

[Hint: expected output of this stage are $G_{p_n}(s)$ and $W_u(s)$].

All the details of student's solution must be reported on the written examination papers. Each step of the proposed solution must be properly discussed.