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

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

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Exam date: 22 February 2017 (001Aver2)

Surname	**Name**
Student ID	

The student is required to solve the following two exercises:

Exercise 1

(A) **4 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

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

- The following a-priori information on the system are available:
  - $G(z)$ is a minimum-phase system;
  - $G(z)$ is a stable system;
  - The steady-state gain of the system is known to be in the range $[3, 7]$
- A set of 30 input-output data pair (available in the data file *S:\LRIC\data_exam_2A*) has been collected to describe the input-output behavior of the plant.
- Input and the output data sequences are known to be corrupted by additive noise signals $\epsilon(t)$ and $\eta(t)$ respectively, having absolute value of amplitude bounded by $\Delta_\epsilon = \Delta_\eta = 0.05$.

(B) **3 Points** — Provide a mathematical formulation of the optimization problems to be solved for the computation of the PUIs.

(C) **5 Points** — Provide a accurate description of the data structure to be built in order to solve the problem with the sparsePOP software.

(D) **6 Points** — Write a MATLAB script for the computation of the PUIs.

Exercise 2

(A) **4 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 nonlinear Hammerstein system where the discrete-time linear time-invariant subsystem is described by the following transfer function

$$G(z) = \frac{\beta_1 z + \beta_2}{z + \alpha_1}$$

and the nonlinear block $\mathcal{N}$ is such that:

$$x_t = \gamma_1 u_t + \gamma_2 u_t^3$$

- The following a-priori information on the system are available:
  - $\gamma_1 = 0.25$
  - $G(z)$ is a stable system;
- A set of 20 input-output data pair (available in the data file *S:\LRIC\data_exam_2A_hammer_ver2*) has been collected to describe the input-output behavior of the plant.
- Output data sequence is known to be corrupted by additive noise signals $\eta(t)$, having absolute value of amplitude bounded by $\Delta_\eta = 0.02$.

(B) **3 Points** — Provide a mathematical formulation of the optimization problems to be solved for the computation of the PUIs.

(C) **5 Points** — Provide a accurate description of the data structure to be built in order to solve the problem with the sparsePOP software.

(D) **6 Points** — Write a MATLAB script for the computation of the PUIs.

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.