Master of science degree in Mechatronic Engineering
Academic Year 2017-2018, First Semester

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

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Surname	**Name**
Student ID	

The student is required to solve the following two exercises:

Exercise 1

1. **3 Points** - Formulate the problem of identifying the mathematical model of the plant in the set-membership framework, on the basis of the following information:
   (a) the plant can be modeled by a discrete-time linear time-invariant system described by the following transfer function
   $$G(z) = \frac{\beta_1 z^2 + \beta_2 z + \beta_3}{z^2 + \alpha_1 z + \alpha_2}$$
   (b) A set of 50 input-output data pair (available in the data file *data_exam_1A*) has been collected to describe the input-output behavior of the plant.
   (c) 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 $\Delta\eta = 1$.
2. **2 Points** - Provide a mathematical formulation of the optimization problems to be solved for the computation of the PUIs.
3. **3 Points** - Provide an accurate description of the data structure to be built in order to solve the problem with the sparsePOP software.
4. **4 Points** - Write a MATLAB script for the computation of the PUIs.
5. **3 Points** - Discuss how to force stability constraints in the identification of the system parameters. Provide the new EFCPS and additional sparsePOP data structures required.
6. **3 Points** - Discuss how to force that the obtained model is a minimum-phase system. Provide the new EFCPS and additional sparsePOP data structures required.

Remark 1: Use the *'active-set'* POP solver.

Exercise 2

1. **3 Points** - Formulate the problem of designing a direct-data driven controller in the set-membership framework, on the basis of the following information:

   (a) The linear discrete-time controller of order n has to match a reference model described by the following transfer function:

   $$M(z) = \frac{0.005z}{z^2 - 1.895z + 0.9}$$

   (b) A set of 100 input-output data pair (available in the data file *data_exam_2A*) has been collected to describe the input-output behavior of the plant.

   (c) 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 $\Delta\eta = 0.1$.

2. **3 Points** - Provide a mathematical formulation of the optimization problems to be solved for the computation of the controller parameter uncertainty intervals (CPUIs).

3. **4 Points** - Provide an accurate description of the data structure to be built in order to solve the problem with the sparsePOP software.

4. **5 Points** - Write a MATLAB script for the computation of the CPUIs and the Chebyshev center of the extended feasible controller parameter set (EFCPS).

5. **3 Points** - Discuss how to force the presence of an integrator in the controller. Provide the new EFCPS and additional sparsePOP data structure required.

Remark 1: The assessment of the controller order n has to be performed by trail and error starting from $n = 1$ until the EFCPS is not empty ($exitflag > 0$).

Remark 2: Use the *'active-set'* POP solver.

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.