MEEC, Maero

Control Computer

2016/2017

first Test

November 9, 2016, 20 hours - V1.16 rooms, v1.15, v1.14, V1.12

Quotation: P1a) 1b), 2c) 1d) 1e) 1f) 1 P2a) 3b) 1c) 1d) P3a 1) 3b) P4a 1) 1b), 1c) 1

Duration: 2 hours. Not any elements of consultation is allowed.

P1. In a given case the manipulated variable • and output are related

the following transfer function

$$\bullet(\bullet) = 1 \frac{\quad}{\bullet + 0.5} \bullet(\bullet)$$

a) Write a difference equation relating the samples • with

of the •.

b) Taking as an initial condition • (0) = 0, use the difference equation

to calculate • (•) When • = 1, ..., 5, suposing that • (•) = 1, • ≥ 0.

c) Under the conditions of b), to determine the exact value $\bar{\bullet}$ whose • (•) if

when approaching • tends to infinity.

d) In order to control the process, causing the output • Have a

next value of the reference •, the process is connected to a controller

full as shown in Figure P1-1. Determine the function of

system closed chain transfer, • (•) / • (•).

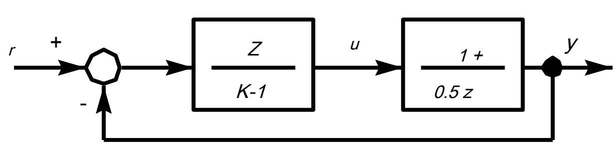

Fig. P1-1. Problem P1. Interconnection between the process and the controller.

e) Show that the closed loop system is stable, and the reference

• is constant, so when • tends to infinity, • (•) tends to

Setpoint •.

f) Tell the feedback system is stable for • = 0.52. Justify.

P2. A continuous system with transfer function

$$• (•) = \frac{• + 1}{• + 2}$$

It is sampled with a D / A and A / D with a sampling interval h

(Consider a generic value $h > 0$).

a) Obtain the equivalent discrete transfer function (due to h).

b) Say which justifies the range of values h which ensures that the function

discrete transfer that has not got zeros outside the circle

unit.

c) Tell justifying the choice $h = 1$ It is adequate.

d) write the equations of state for performing the function of

discrete transfer.

Help: 1,(• 0) • for Z ZZK1 • Z and kh T • • z • ez kh T $\mathscr{L}$ (• -••) = 1 • + •

P3. Consider a system modeled by the difference equation:

() • • •1 () y ty TVT •1 () • bu (P2-1)

on what • is a zero mean noise signal. an experiment is performed in system to collect data in order to estimate the parameters *The* and *B* . With data obtained for *u* and *y* The following quantities were calculated:

$$\sum_{i=1}^{999} y^2(i-1) = 30 \quad \sum_{i=1}^{999} u^2(i-1) = 50 \quad \sum_{i=1}^{999} y(i)y(i-1) = 1$$

$$\sum_{i=1}^{999} u(i-1)y(i-1) = 20 \quad \sum_{i=1}^{999} u(i)y(i) = 36$$

a) Determine the estimated least squares parameter *The* and *B .*

Present intermediate calculations.

b) Suppose that • (•) = • (•) + •• (• - 1). Explain the minimum algorithm

square extended to estimate •, • and •. Write the equations

define the algorithm but <u>not</u> the need to apply for

estimates.

P4. The temperature • a heat accumulator for heating water

satisfies the following difference equation

$$\bullet (\bullet + 1) = \alpha \bullet (\bullet) + (1 - \alpha) \bullet$$

on what • It is a constant and α is a constant parameter which verifies 0 <α <1.

a) Determine the value of the equilibrium temperature (ie, a value

temperature such that if the initial condition is equal to it, so

temperature always remains constant) $\bar{\bullet}$ in function of α and •.

b) Suppose that the initial state is not stable temperature.

Obtain a difference equation for the deviation

$$\bullet (\bullet) = \bullet (\bullet) - \bar{\bullet}$$

W) <u>Without</u> use the concept of pole <u>nor</u> the transformed Z, show that • (•)

tends to zero when • tends to infinity, meaning that the balance $\bar{\bullet}$ is

asymptotically stable.