TÉCNICO LISBOA

MEEC, Maero

Control Computer

2015/2016

first Test

November 4, 2015, 20 hours - F2 rooms, F3, F4.

Quotation: P1-a) 2b) 1c) 2d) 1, P 2 a) 4 b) 1, P3-4, P4) b 1) c 1) d 1) and 1) 1

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

P1. It is intended to determine the model a discrete-time AC motor continuous, permanent magnet, which drives a joint of a robot arm, as shown in Fig. The relationship between the voltage electrical • (•) applied to the motor and position angular • (•) its shaft, in continuous time •, They are related by the transfer function

$$\bullet(\bullet) = 1 \quad \frac{}{\bullet(\bullet + 1)\,.} \qquad \text{(P1-1)}$$

To simplify the calculations, climbing units are used (ie this model is much slower than a typical real engine). Answer the questions follows (all calculations show):

a) Determine the equivalent view discrete transfer function to terminals converters D / A and S / A connected to the motor operating and synchronously with a sampling interval of 1s.

b) Write a difference equation that relates the input to the output discrete time.

c) Write the matrix form the corresponding equations of state.

d) Tell 1s reasonably considered that a sampling interval is convenient for this engine.

Help: 1,(• for Z 0) • ZZK1 ( ) • KH Z z H1z ( ) 2 Z and khT •• z / • ez hT 1 • ≅ 0.37

P2. With regard to a burner of a furnace of a thermoelectric group, we intend to build a model that relates the command *u* the system oil burning heating the logarithm of the viscosity of the oil, *y.* THE P2-F1 figure shows a simplified view of the system.

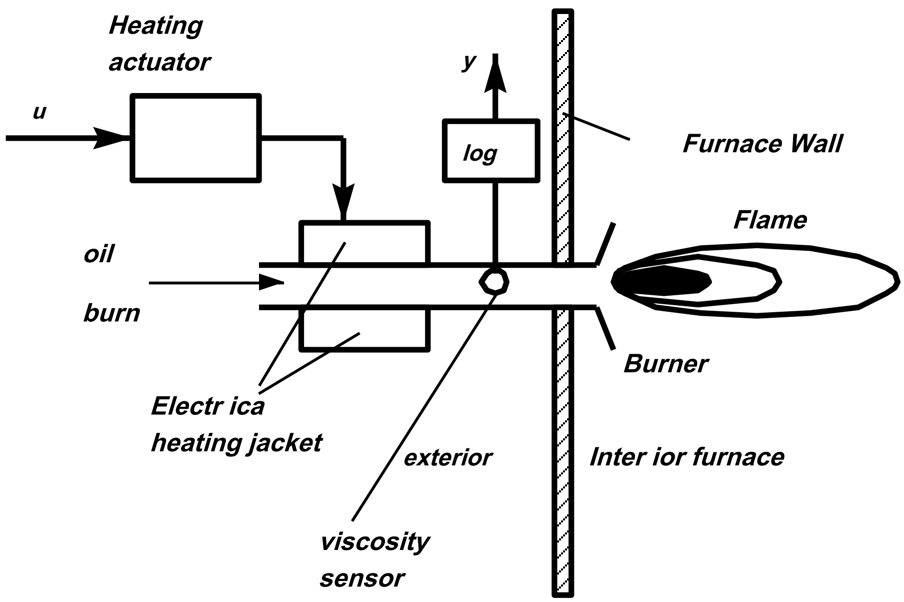


Figure P2-F1. schematic view of a furnace burner of a group Thermocouple, with the heating system of burning oil.

It is assumed that the system can be modeled by difference equation:

( ) • • •1 ( ) y bu ty •1 ( ) • (t) et (P2-1)

on what *and* signal is white, Gaussian, zero mean and unit variance. IS conducted an experiment in the system to estimate the parameters *The* and *B .* With data obtained for *u* and *y* The following quantities were calculated:

$\sum_{i=1}^{999}$ ^{2} iy•1 ( ) • 28 $\sum_{i=1}^{999}$ ^{2} iu•1 ( ) • 52 $\sum_{i=1}^{999}$ ( ) iyiy ( ) • 1

$$\sum_{i=1}^{999} \bullet_1() \; iuiy() \bullet 19 \qquad \sum_{i=1}^{999} () \; iuiy() \bullet \bullet 36$$

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

Present intermediate calculations.

b) Say, justifying quantitatively, which is more accurate estimates.

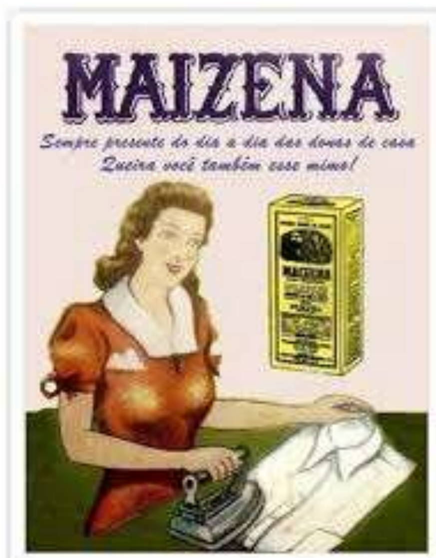
P3. Are made • comments • 1, • 2, ... • • of a random variable of Gaussian zero mean, but with unknown variance σ^2. It is known so that (with some notation abuse)

$$\bullet(\bullet\,\bullet) = \frac{1}{\sigma\sqrt{2\pi}} \{\bullet\bullet\bullet - \bullet\bullet^2 \; 2\sigma^2\} \qquad \text{(P3-1)}$$

Assuming that the observations are independent, determine the estimated maximum likelihood parameter σ on the amounts of • 1, • 2, ... • •.

Help: $\frac{d}{dx}\log(\bullet) = \frac{1}{x}$

P4. The Brutopia is, as the name implies, a charming country of friendly locals, situated somewhere between Bechuanaland and Patatávia. One of its main wealth is the production of maize, the brutopianos They use for various purposes, such as filling mattresses, produce environmentally friendly fuel, shoot each other, feeding pigeons, ironing the shirts (see picture!) or even as food (it is the basis of multi-cultural Cornstarch flour, and very popular in Brutopia that traditionally make delicious sweets).



Corn producers Brutopia observed that the demand • (•) of corn in market in a given year • It is a linear function of the price • (•) the same year, given by

$$\bullet(\bullet) = \bullet_0 - \bullet\bullet(\bullet) \qquad \text{(P4-1)}$$

on what • 0 and • positive parameters are known (through studies of

brutopianos competent economists).

On the other hand, it is also known that corn production • (•) in the year • is

a price function • (• - 1) practiced in the previous year, given by

$$• (•) = • 0 + •• (• - 1) \quad \text{(P4-2)}$$

on what • 0 and • parameters are known with •> 0.

a) Assume that the generic year • the price is adjusted so that all

corn production available this year (which depends on the price in the year

above) be sold. Write a difference equation that relates

the price for two consecutive years (ie that relates • (• - 1) with

• (•)).

b) Find a function of the parameters that regulate the corn market

in Brutopia (i.e., due to • 0 •, • 0 and •) how much ¯• in

balance of corn. In other words, say what price ¯• Corn such that, if

check in a given year, will remain the same in subsequent years.

c) is • (•) the price deviation • (•) in the year • relative to the price of

balance ¯•, that is

$$• (•) = • (•) - ¯• \quad \text{(P4-3)}$$

Derive an equation of differences observed for the deviation • (•).

d) Based on the deduced equation for deviation • (•) in c), give

a condition to ensure that the parameters • (•) approaches

balance ¯• When • increases.

e) Tell justifiably when there are price variations • (•) these are

dull (always increasing or always descrescentes) or if there is

swings.