First Simulation Project. Control engineering.

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"In accordance with the Tecnológico de Monterrey Student Code of Honor, my performance in this exam will be guided by academic honesty."

You should upload a **word** or **PDF** file in which all the results are provided. The word or PDF should be self-explaining, i.e. it should contain images of the Simulnk ® diagram, the transfer function of the system, the control equation, the Sisotool plots (if needed), the output of the system and the input to the system. Also, you can do your mathematical computation on a paper and include images of them.

The report should be presented by System, not by question. You should also include a .m file per system, which generates all the required variables, and a Simulink ® file per system. The exam will be graded with both the word or PDF file and the workspace. <u>Follow the structure defined and attached on the 2st simulation project. It is very important that you upload a ZIP file, otherwise the name of the variables will be changed.</u>

The simulation project is **individual** and depends on the following parameters. If there were 2 people with the same data, both exams will be cancelled with a violation to Academic Honesty will be reported, with a final grade of the course equal to 1/100.

Part 1. 80 points. The parameters for this section are:

$$\boldsymbol{a} = Birth\ Day, \quad \boldsymbol{b} = Birth\ Month \text{ and } \boldsymbol{c} = a + b$$

(For instance, for someone born in Sep 16th $a = 16, b = 9$ and $c = 25$)

make sure to include the values used for a, b and c at the beginning of the report.

System 1. (16p)

$$G(s) = \frac{Y(s)}{U(s)} = \frac{a}{cs + b}$$

System 2. (16p)

$$G(s) = \frac{Y(s)}{U(s)} = \frac{ac\, e^{-0.004s}}{6s^2 + c(a/25)s + c^2}$$

System 3. (16p)

$$G(s) = \frac{Y(s)}{U(s)} = \frac{4a\, e^{-0.006s}}{(s + 2b)(s + b)}$$

System 4. (16p)

Identification of the assigned Step Response.

<u>(Make sure to include the validation plot in your report)</u>

Symbology:

M – Requires Math computation. It can be made in paper or in Matlab®. Make sure it's easy to follow on your report.

S – Requires Simulink® Simulation. Include clear images of the plots and the Simulink Diagram.

D – Requires Diagrams, for instance in Sisotool®.

For each of the enlisted systems Compute, Design and Simulate as required:
If any of the methods cannot be used, justify and put all your answers in the cell equal to 0.

1. **(3p)** M S D (diagram plot is probably not required)

   Proportional Control Design. Design a proportional controller to obtain a steady state error ≤ 5%. If your design is unstable, justify your answer and explain. Also, if it is unstable, select a stable gain (with greater error), compute the expected error and validate with a simulation.

2. **(3p)** M S

   PID Design. Design a PID controller, using the Sustained Oscillations method, to follow a reference r(t)=b.

3. **(3p)** M S

   PID Design. Design a PID controller, using the Damped Oscillations method, to follow a reference r(t)=b.

4. **(3p)** M S

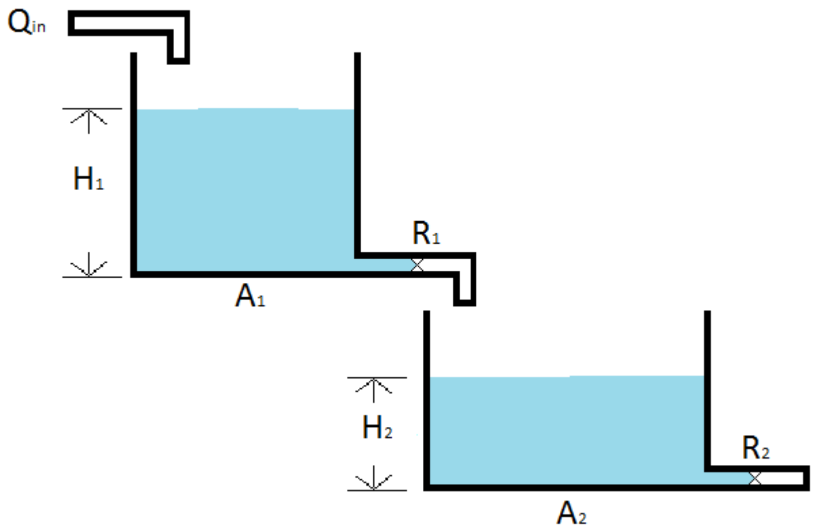
   PID Design. Design a PID controller, using the Algebraic method, to follow a reference r(t)=b.

5. **(4p)** M S

   PID Design. Design a PID controller to follow a reference r(t)= at . Estimate the steady state error with your design and include it in your answers.

Sistema 5. (36p)

Consider the following system. The flow in the tank above is the input to the system (manipulated variable Qin). The parameters for this example are given in the Workspace file for this project, and individually assigned.



Parameters H1 and H2 can be the output of the system. Parameter H1max and H2max correspond to the real height of the tank and will be used on the final question. Finally, parameters A1, R1 and A2, R2 are the area and the resistance to the laminar flow of Tank 1 and Tank 2 respectively.

1. (0p – it is already done) Obtain the symbolic transfer function M
   a. H1(s) / Qin(s)
   b. H2(s) / Qin(s)
2. (0p – it is already done) Obtain the transfer function with the parameters assigned to you. M
   a. H1(s) / Qin(s)
   b. H2(s) / Qin(s)
3. (8p) Design a proportional controller for H1 with the assigned reference Ref_1. The steady state error should be less than 10%. Compute and simulate. M S
4. (8p) Design a proportional controller for H2 with the assigned reference Ref_2. The steady state error should be less than 10%. Compute and simulate. M S
5. (10p) Design a PID controller for H1 with the assigned reference Ref_1. Compute and simulate. M S
6. (10p) Design a PID controller for H2 with the assigned reference Ref_2. Compute and simulate. M S

Variable assignation.

1	A00226442
2	A00343779
3	A00344416
4	A01113720
5	A01113836
6	A01114172
7	A01114202
8	A01227225
9	A01228853
10	A01229268
11	A01229469
12	A01233216
13	A01364714

14	A01631925
15	A01632255
16	A01632734
17	A01632954
18	A01633178
19	A01633231
20	A01633279
21	A01633926
22	A01634022
23	A01634734
24	A01634847
25	A01756444
26	A01756812

To use the variables, use the workspace named: PS1.mat

The assignation for each student is on the table above and it will be used in code as a variable "n".

For System 4, use the variable DataID.

You can access such variable with: `MyVariable=DataID{n}`

MyVariable can have any name and will have two columns.

You can plot them using: `plot(MyVariable(:,1), MyVariable(:,2)`

To access the rest of the variables, use VariableName(n)

For instance, for a student with n=15, `A1(15)` is the Area of the first tank.