Classic Control Theory 101 - Laboratory session #1

Analysis of a first order system

Introduction

The aim of this session is a first contact of the students with **Scilab**, as well as the development of a simple function to evaluate first order model for a mechanical and hydraulically systems. The report and code generated (*code from technical report and Scilab code)* must be submitted by the **classroom git-hub** platform and must include the next sections:

- Introduction
- Methodology (what you did and use)
- Results and Discussion (what you found and saw)
- Conclusions
- References

Specifically the technical report can be done using **Markdown**, **LaTeX** or **R-Studio** syntax.

Students must consider that if any kind of plagiarism would cause a zero as the grade of the technical report

Note: Any doubts about this directions please do not hessite in contact me by email.

Directions

Most of the laboratory sessions will be divided in several parts, due to its complexity or information required to accomplish the technical report.

The part II will be the statement of a more complex system, however in second part students will develop completely the methodology, also students should develop a simple function in **Scilab** to calculate the time response of a first order system by numerator and denominator transfer function's (**TF**) coefficients.

This means for the **TF**:

$$TF = \frac{1}{1+2s}$$

Scilab should get:

```
num=[1];
den=[2 1];
TF=myFunction(num, den)
```

Thus the **myFunction** response should be a plot with the **TF** response in time domain.

Submission dead line

The technical report and complete code must be submitted by **Classroom** in the dead line defined during lab sessions. **No extra time would be given to any group**.

Part 1: First order system

In this first part of laboratory students must understand the procedure to obtain a generic transfer function from a first order system.

Unit Step Response

The response of a system to the unit step input is called the unit step response. If the problem you are trying to solve has initial conditions you need to include a zero input response in order to obtain the complete response.

Students must take in count the example from inversa Laplace transformations. Considering a system with input $u(t)$ and output y(t)$$, the system will have a transfer function:

$$H(s) = \frac{Y(s)}{U(s)}$$

thus, there is possible to calculate the output with zero initial conditions by:
$$Y(s) = X(s)H(s)$$

and considering an unit step input:

$$Y(s) = \frac{1}{s}H(s)$$

Step-Response of a first order system

Now consider a first order generic transfer function:

$$H(s) = \frac{bs+c}{s+a}$$

where a, b and c are real numbers, then obtain the unit step response of $H(s)$:
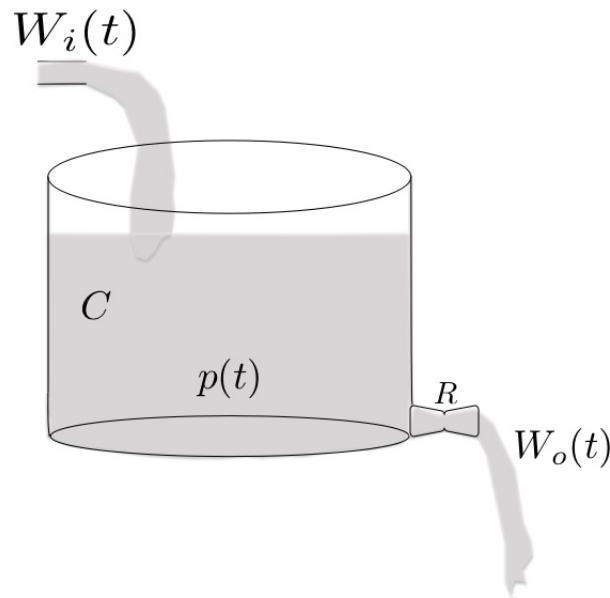$$Y(s) = \frac{1}{s}\frac{bs+c}{s+a}$$

then the previous equation can be rewritten as follow:
$$Y(s) = \frac{A}{s} + \frac{B}{s+a}$$

now students must obtain a generic unit step response equation an **report it**.

Example

Try to use the obtained unit step response for the next system and compare the answer with the Scilab's response.

Esquema de sistema hidráulico

considers that the tank is filled at a flow rate of W_i ($m3/sec$), the input to the system. The output is the discharge flowrate, W_o in ($m3/sec$). If $W_i = W_o$, the level, $h(t)$, remains constant. If $W_i > W_o$, the level, h, rises. If $W_i < W$, the level, h, falls.[1]

Part 2

During second part, students must test their own code (*myFuction*) with a first order system proposed in the previous example section, then compare the results obtained by their own function against the **scilab** code. The technical report must include all procedure to:

- Obtain the energy balance equation
- Obtain the transfer function
- Calculations using your own Area and resistance on the hydraulic system
- step-response by the function and scilab's function