Laboratory 4: Position control of a mass.

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Abstract---

This document presents the procedures and analyzes necessary for the design and implementation of a PID-type control for the position of a load through a motor and a pulley system, implementing graphical, analytical and experimental methods to obtain system parameters.

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In this document are presented the required procedures and analysis for the design and implementation of a PID control for the positioning of a load through a motor and a pulley system, using graphic, analytic and experimental methods for the obtaining of the system ´s parameters.

Keywords---

General Objective--- Implement a PID-type control for the control of the position of a mass (DC Motor + Pulley System + Mass)

Specific Objectives--

* Graphically identify the model of a system of first and /or second order.

* Model a first order and/or second order system.

* Design a PID control for the pulley system.

1. INTRODUCTION

It is sought that the position of a mass coupled to a pulley system, driven through a motor, presents certain characteristics in the way in which the system responds to an input, such as a settling time, an error in stable state , and a type of response, in this case it is required that the system, in closed loop, have a settling time equal to 50% of the settling time in open loop, a steady state error of 0 and an underdamped response type with a damping coefficient equal to 0.6. For this, a PID-type control can be implemented to ensure these parameters when the system is fed back.

2. THEORETICAL FRAMEWORK

The typical response of first-order systems is shown in **Figure 1,** in which it can be seen that there is no overshoot, therefore, they are relatively slow systems [1]. For example: heating an oven.

The transfer function of a first order system is as follows:

$$G(s) = \frac{K}{\tau s+1} \qquad Eq. 1$$

where K is the system gain and τthe time constant.

$$K = \frac{Output}{signal\ amplitude\ Input\ signal\ amplitude} = \frac{\Delta y}{\Delta u} \qquad Eq.$$

The value of the time constant is obtained on the graph, for this, the time corresponding to where the output value is 63% Δy.

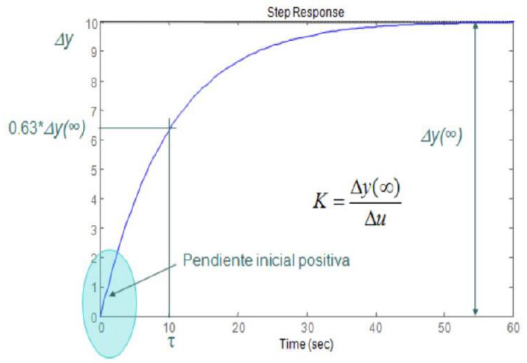


Figure 1. Typical response of a 1st order system.

Similarly, a graphical response can be found for a second-order system on step input.

3. MATERIALS

* Software: MATLAB ®

* White coat.

* PID control circuit (operational amplifiers, source, resistors, capacitors, cables, breadboard, oscilloscope).

* Reducer motor.

* Pulleys.

* System support.

* Ropes

4. PROCEDURE

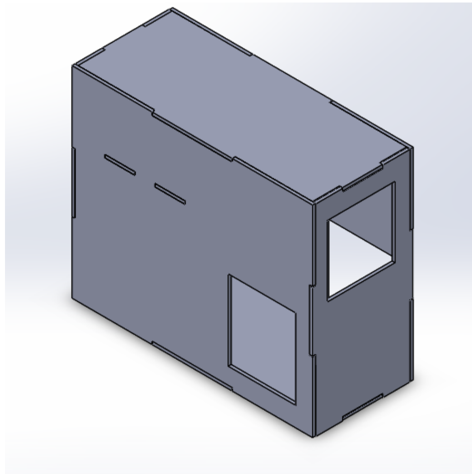


Figure 2. Isometric view of the plant support assembly.

It was designed in such a way that the motor can be supported inside and that there is a space for the belt that drives the pulley.

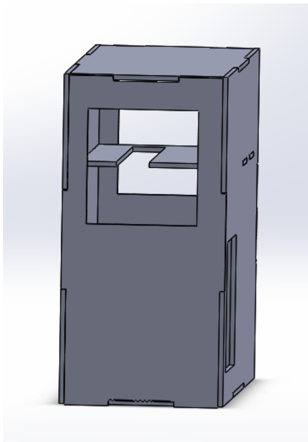


Figure 3. Front view of the plant

support assembly Isometric view of the plant support assembly.

As can be seen, the motor is coupled to a driving pulley, whose movement is transmitted to a driven pulley through a belt; To reduce the torque of the load, seen from the motor, a hoist is implemented, an arrangement of fixed and mobile pulleys that reduce the force necessary to lift an object, as shown in **X.**image

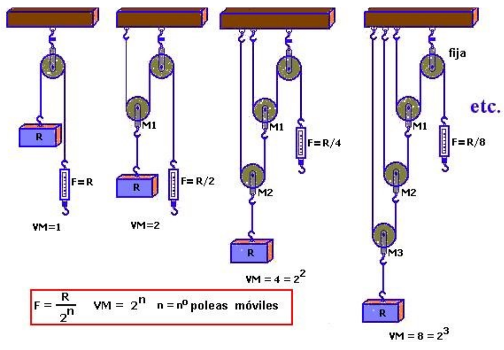
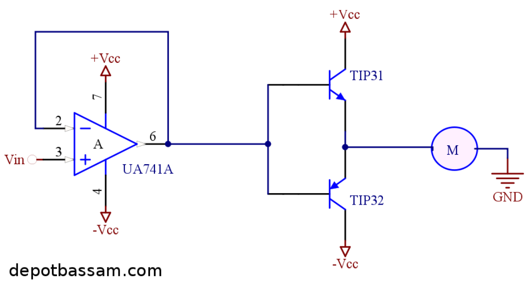


Figure 4. Pulley system

Inthis case, there is a hoist that reduces the force by half.

Open loop system

To measure the position of the mass, there is a linear potentiometer with flat travel**, which will be the output of the system; a driver or "*push pull" is implemented,* which increases the current coming from the generator and whose structure is evidenced in **figure 5.**



The complete plant is characterized, measuring and observing the behavior of the output (Potentiometer), with respect to an input, in this case a train of pulses on 0 (Only positive voltages).

Closed loop system

Image 1 shows the response presented on the oscilloscope when the system is closed loop.

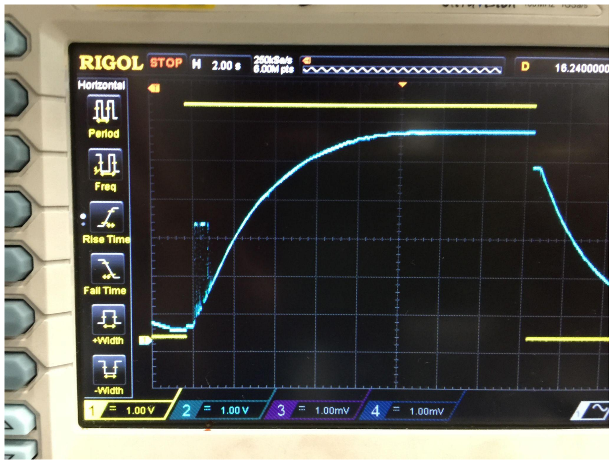


Image 1. Output of the system in closed loop

When obtaining these values in the oscilloscope, the data will be transferred in csv through a USB to later be treated in specialized software to obtain the transfer function in a much more precise way.

5. ANALYSIS OF RESULTS

After obtaining the output signal of the system, the order of the system is identified from said signal, then the transfer function is obtained, this is achieved by using the cursors of the oscilloscope to obtain the merit parameters of the system and formulate a transfer function, then it is simulated in MATLAB and the corresponding responses are observed.

Once the transfer function is obtained, a PID type control is designed from the given design specifications, with this a desired polynomial is generated that gives us the value of the required constants; the corresponding assembly is carried out and the system is fed back, the output is observed with respect to the input, and the control signal. The same procedure is repeated to obtain a control before a speed entry (Ramp).

6. CONCLUSIONS

*Given that a good design of the physical plant was carried out, obtaining the transfer function is completed, to then implement different types of control and be able to control the position of the mass of the hoist.

7. REFERENCES

[1] B. Kuo, Automatic Control Systems, Prentice Hall, 1996.

[2] Q. INC, Instructor Workbook: SRV02 Base Unit Experiment for Matlab, 2011.