CASE STUDY #4: Time response of first and second order systems

The goals of this case study are to evaluate the properties of the time response in different systems, and to find the equations that describe the system through their time responses.

SECTION #1

A system has the step response displayed in Figure 1 at the end of this Laboratory Exercise. Find the differential equation that describes the system.

Note.- Use different approaches to calculate the time constant

SECTION #2

Given the following circuit:

![Circuit Diagram](image)

a) Find the mathematical equation for the step response (voltage across capacitor)
b) Plot the time response found in a)
c) Through the time-response plot found in b), find the values of Ts and Tr
d) Compare these values found on c) with the values for the same parameters calculated analytically through the equation found in a). Explain and justify possible differences.
SECTION #3

The figure shows the zero/pole diagram (s-plane) for a system, G(s):

a) Write the equations that describe the output of the system if the input signal is:
- a step signal.
- a impulse signal
Note.- For simplicity, assume a standard Transfer Function, i.e., the value of the Transfer Function in the origin of frequencies is 1 (G(0) = 1).

b) Using the output signal time plot for a step signal input, estimate the values of the characteristic parameters for a second order system:
- natural frequency and damping ratio

c) Calculate the same parameters (natural frequency and damping ratio) using the relationships between them and the poles in the zero/pole diagram (s-plane)

d) Using the time response plot for a step signal, estimate the following values:
- Peak Time (Tp)
- Percent Overshoot (%OS)
- Rise Time (Tr)
- Settling Time (Ts)
FIGURE 1
ELECTRICAL ENGINEERING TECHNOLOGY PROGRAM
EET 433 – CONTROL SYSTEMS ANALYSIS AND DESIGN

CASE STUDY #4: Time response of first and second order systems

SUMMARY SHEET

To be completed during the laboratory period
Submit it to the instructor at the end of the laboratory period

1.- Time Constant for Section 1:

2.- Time Constant for Section 2:

3.- Peak Time and %OS for Section 3:

Instructor’s Signature and Date: