Practical Lab: First-Order System Analysis

Objective: This practical lab is designed to help students or engineers understand and apply the concepts of first-order system analysis. Participants will learn how to model a first-order system, analyze its time response, and observe the effects of different system parameters on its behavior.

Materials:
1. MATLAB or a similar numerical computing environment.
2. Computer with MATLAB installed.

Procedure:

1. Modeling a First-Order System:

   - Open MATLAB on your computer.

   - Define the system parameters:
     - Gain (k) and Time Constant (T).

   - Create a first-order transfer function using the `tf` function in MATLAB.

   - Plot the step response of the system using the `step` function.

2. Analyzing the System Response:

   - Observe the response characteristics, such as rise time, settling time, and overshoot, on the plot.

   - Use the `stepinfo` function in MATLAB to obtain and display numerical values for these response characteristics.

3. Exploring Different Scenarios:

   - Change the values of the gain (k) and the time constant (T) and observe how it affects the system's time response.

   - Plot and analyze the step response for different combinations of gain and time constant values.

4. Ramp Input Response:

   - Modify the script to input a ramp signal (u_ramp = 0.1 * t) into the system using the `lsim` function.

- Plot the system's response to the ramp input.

   - Analyze the response characteristics, including the steady-state error.

5. Parabolic Input Response:

   - Modify the script to input a parabolic signal (u_parabolic = 0.01 * t.^2) into the system using the `lsim` function.

   - Plot the system's response to the parabolic input.

   - Analyze the response and observe how the system reacts to a changing rate of input.

6. Discussion and Analysis:

   - Discuss your observations with respect to changes in gain, time constant, and input signals.

   - Analyze the effect of system parameters on response time and accuracy.

7. Report and Presentation:

   - Prepare a report summarizing your findings, including the impact of different parameters on the system's behavior.

   - Create a presentation to share your results and insights with others.

Conclusion:

This practical lab provides hands-on experience in modeling and analyzing first-order systems. Participants will gain a deeper understanding of system behavior, response characteristics, and the influence of gain and time constant on system performance. This knowledge is valuable in control system design and analysis.