# Abstract

Provide a concise summary of the experiment, including the objective, methods, main results, and conclusions. Limit to 1 paragraph.

# Introduction

## Objective

Clearly define the purpose of the experiment, specifying the goals of using TCLab.

## Methods

Describe the experimental approach briefly, mentioning the apparatus, i.e., Arduino with two heaters and temperature sensors.

## Apparatus

Briefly describe the TCLab system, its components, and its relevance for temperature control studies.

# Theory

## Dynamic Modeling

Describe the theoretical models used, such as the First Order Plus Dead Time (FOPDT) model, and discuss its relevance for temperature response.

## Parameter Estimation and Control

Explain any regression or estimation techniques used to determine model parameters (e.g., Kp, τp, θp).

## Controller Design

Describe the design approach for PID control, including initial tuning parameters (e.g., Kc, τI, τD) and considerations.

# Results and Discussion

## Data Analysis

Present key results from the experiment, including model identification data and response graphs for the heaters.

## Comparison with Theory

Discuss how well the experimental results align with the theoretical model (FOPDT), address key questions, and the model IAE (Integral Absolute Error).

## Controller Tuning and Performance

Summarize the controller tuning process and results, including parameters like Kc, τI, τD, and controller IAE (Integral Absolute Error).

# Conclusion

Summarize the main findings, highlighting conclusions from the data analysis and control performance.

Provide recommendations based on the findings, addressing potential improvements and future work.

# Appendix (Optional)

Include additional information about model fitting, controller tuning, and any specific TCLab information used in the experiment. Omit raw data and raw code.