UM–SJTU Joint Institute

Intro to Signals and Systems (ECE2160J)

Lab3 Report

LTI System

Instructed by

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1 Objectives

The objective of lab3 is to understand feedback control.

2 Experimental results

2.1 Open Loop Control——Plant

In this experiment, we constructed a plant circuit using two capacitors, two fixed-resistance resistors, and an operational amplifier. The resistors used had a resistance of 10kΩ, and we used capacitors with capacitance of 100µF and 0.22µF, respectively. The output signal is measured as the output voltage of the operational amplifier.

2.1.1 Part 1

For the experiment, we applied an impulse input signal with an amplitude of 1V, a width of 0.1s, and a frequency of 1Hz. The function generator was configured to generate this impulse signal, and we observed the corresponding output signal in the oscillator. Below is a representative illustration of what the results might look like:

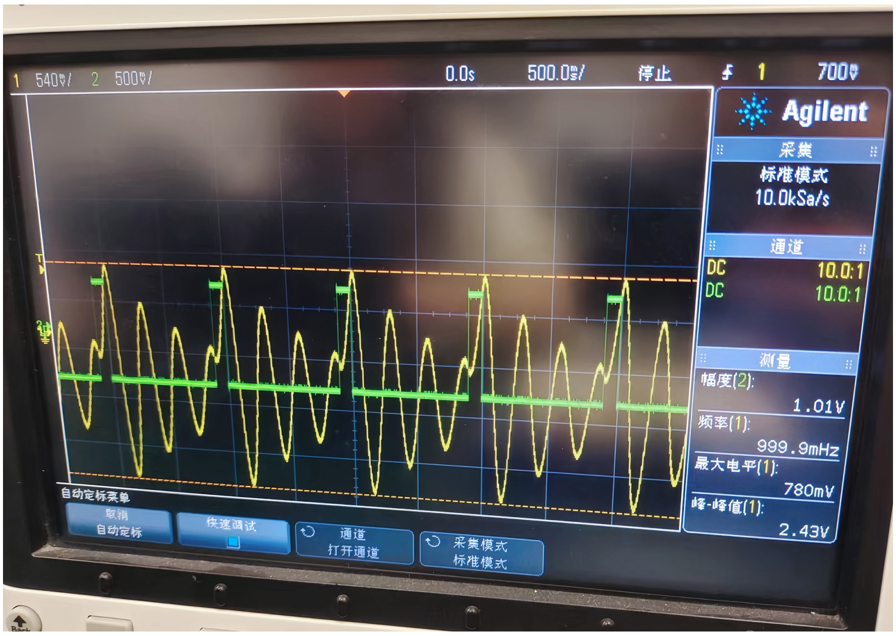

Figure 1: Lab result1

2.1.2 Part 2

In this phase of the experiment, we investigated the step response of the plant circuit to a specific input signal. The input signal was a step function with an amplitude of 1V and a frequency of 1Hz, generated by configuring the function generator accordingly.

By carefully observing and recording the input and output signals on the oscilloscope, we analyzed how the plant circuit responded to the step input signal. The obtained results are illustrated in the following figure:

Figure 2: Lab result2

2.2 Feedback Control circuit

In this stage of the experiment, we introduced a feedback control circuit to the existing plant circuit. The feedback control circuit was constructed with specific component values: R1 and R3 were set to 150kΩ, R2 was set to 3kΩ, and C3 was set to 0.47µF.

2.2.1 Part 3

To analyze the impulse response of this modified circuit, we applied an impulse input signal with an amplitude of 1V, a width of 0.1s, and a frequency of 1Hz. The function generator was adjusted to generate the impulse signal, and we carefully observed and the resulting input and output signals displayed on the oscilloscope.

The captured data and observations provided valuable insights into how the feedback control circuit influenced the plant circuit's response to the impulse input signal. The graphical representation of the obtained results is presented below:

Figure 3: Lab result3

2.2.2 Part 4

In the next phase of the experiment, we focused on examining the step response of the plant circuit with the newly added feedback control circuit. The feedback control circuit comprised specific component values, with R1 and R3 set to 150kΩ, R2 set to 3kΩ, and C3 set to 0.47μF.

To analyze the step response, we applied a step input signal with an amplitude of 1V and a frequency of 1Hz. The function generator was configured to generate the step signal, and we carefully observed and recorded both the input and output signals displayed on the oscilloscope.

The collected data and observations allowed us to investigate the plant circuit's behavior in response to the step input signal, considering the effects of the feedback control circuit. The graphical representation of the obtained input and output signals is presented below:

Figure 4: Lab result4

3 Discussion and Error Analysis

Upon comparing the output of the feedback circuit with that of the tested circuit, it becomes evident that the feedback circuit effectively stabilizes the initially unstable system. The experimental results align well with the theoretical predictions.

However, it is essential to acknowledge that certain discrepancies might arise due to the internal design of the operational amplifiers used in the experiment. These operational amplifiers, being real components rather than ideal ones, will introduce some level of error into the measurements and performance of the circuit. This outcome aligned with my initial expectations and mirrored the concepts I had learned in class.

4 Conclusion

In this experiment, we compared the responses of our plant and feedback control system to different input signals. The results closely matched theoretical calculations, with minor errors possibly due to the sequential nature of the input signals. The open-loop circuit proved simple to build, and the feedback control improved stability while avoiding saturation. This experiment holds practical importance, as feedback control is vital for real-life applications, where inputs are based on environment outputs and responses.