Report By: Xinchen Yao

# Total \_\_\_/90

Lab Partner: Rebecca Rauschmayer

Lab TA: Junjie Gao

Section: AB2

## Part 1. \_\_\_/44

### (A). Theoretical Performance Criterion. \_\_/8

Table 1, Theoretical Values according to Fig 5.1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Gains 1**  **P1 = 0.15** P2 = 0 | **Gains 2**  **P1 = 0.25** P2 = 0.35 | **Gains 3**  **P1 = 0.1** P2 = 0.5 | **Gains 4**  **P1 = 0.81**  **P2 = 0.96** |
| ς | 0.11 | 0.47 | 1.01 | 0.50 |
| ωn | 22.7 | 29.4 | 18.6 | 56.2 |
| **Mp (%)** | 70.7% | 18.7% | 0.0% | 16.1% |
| t­r (s) | 0.052 | 0.054 | 0.182 | 0.025 |
| t­s (s) | 1.022 | 0.225 | 0.271 | 0.091 |

### (B). Experimental Performance Criterion. \_\_/12

Note that **Mp,** t­r, t­s are calculated with respect to the steady-state response, not the reference signal.

Table 2, Experimental Values, Section I (Analog Computer)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Gains 1**  **P1 = 0.15** P2 = 0 | **Gains 2**  **P1 = 0.25** P2 = 0.35 | **Gains 3**  **P1 = 0.1** P2 = 0.5 | **Gains 4**  **P1 = 0.81**  **P2 = 0.96** |
| **Mp (%)** | 56.16% | 2.82% | 0.00% | 4.82% |
| t­r (s) | 0.048 | 0.060 | 0.257 | 0.031 |
| t­s (s) | 0.254 | 0.104 | 0.391 | 0.075 |

Table 3, Experimental Values, Section II (WinCon)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Gains 1**  **P1 = 0.15** P2 = 0 | **Gains 2**  **P1 = 0.25** P2 = 0.35 | **Gains 3**  **P1 = 0.1** P2 = 0.5 | **Gains 4**  **P1 = 0.81**  **P2 = 0.96** |
| **Mp (%)** | 54.85% | 5.389% | 0.189% | 6.74% |
| t­r (s) | 0.042 | 0.046 | 0.185 | 0.032 |
| t­s (s) | 0.278 | 0.114 | 0.225 | 0.070 |

Table 4, Experimental Values, Section III (WinCon with Friction Compensation)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Gains 1**  **P1 = 0.15** P2 = 0 | **Gains 2**  **P1 = 0.25** P2 = 0.35 | **Gains 3**  **P1 = 0.1** P2 = 0.5 | **Gains 4**  **P1 = 0.81**  **P2 = 0.96** |
| **Mp (%)** | unstable | 18.12% | 1.60% | 12.5% |
| t­r (s) | unstable | 0.046 | 0.144 | 0.028 |
| t­s (s) | unstable | 0.168 | 0.232 | 0.124 |

### Compare results from Section I with those from Section II \_\_\_/8

*Note any differences and characteristic similarities. Should they be the same? If they are different, why do they differ?*

Section 1 has larger overshoot and smaller settling and rise time compared with section 2.

They should be the same. The reason might be that the setting in the analog computer is not accurate enough.

### Compare results from Section II with those from Section III \_\_\_/16

*Note any differences and characteristic similarities. Should they be the same? If they are different, why do they differ? Also, what are the effects of friction on the response of the system (How does it affect Mp, tr, and ts)?*

Section3 has larger overshoot, smaller rise time and larger settling time.

They should be different, as the friction is compensated in 3, which make damping ratio smaller.

Larger friction causes smaller overshoot, larger rise time, and smaller settling time.

## Part 2. \_\_\_/18

**Compare performance of your design to the Specs \_\_\_/10**

Did you meet the specifications given in the prelab (<15% overshoot, < 30 ms rise time)? If not, suggest improvements to do so. (i.e. What gains were close – what values would be better?)

We almost did. The overshoot was 7.5% and rise time was 35ms.

To improve, we should increase Kp.

### Explain how unmodeled plant dynamics might cause problems \_\_\_/8

*Give an example of dynamics that were un-modeled (or ignored) on the prelab. What problems could these dynamics cause?*

We ignored static friction in prelab. We would thus get smaller rise time.

***Part 3. \_\_\_/16***

**Theoretical and measured Ess \_\_\_/8**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Gains 1**  **P1 = 0.15** P2 = 0 | **Gains 2**  **P1 = 0.25** P2 = 0.35 | **Gains 3**  **P1 = 0.1** P2 = 0.5 | **Gains 4**  **P1 = 0.81**  **P2 = 0.96** |
| Theoretical | 0.0% | 0.0% | 0.0% | 0.0% |
| **Section I** | 3.59% | 0.76% | 8.20% | 1.05% |
| **Section II** | 0.10% | 0.83% | 6.20% | 0.24% |
| **Section III** | unstable | 0.02% | 4.33% | 0.18% |

Table 5, Steady-state error

### What gain adjustments helped decrease steady-state error? \_\_\_/8

*Give a general rule for which gain values give the lowest steady state error.*

In PD control, a higher Kp would lead to lower steady state error. In PID control, a higher Ki would minimize steady state error significantly.

Part 4. \_\_\_/12

**Friction Values \_\_\_/6**

|  |  |  |  |
| --- | --- | --- | --- |
| **Friction Values** | Lab 4 | Lab5, Section III full values | Lab5, Section III **Reduced values** |
| Coulomb Positive | 0.010590 | 0.014 | 0.001 |
| **Coulomb Negative** | -0.012094 | -0.014 | -0.001 |
| **Viscous Positive** | 0.000041 | 0.001 | 0.0006 |
| **Viscous Negative** | 0.000028 | 0.001 | 0.0006 |

Table 6, Friction Values

### Discuss the Variation in the friction Values \_\_\_/6

*How much did you have to reduce the friction values? How do both results from lab 5 compare with lab 4?*

We reduced the values by about 10 times. The coulomb friction is quite close but viscous is much smaller.