

Total ____/90

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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
ζ	0.11	0.47	1.01	0.50
ω_n	22.7	29.4	18.6	56.2
M_p (%)	70.7%	18.7%	0.0%	16.1%
t_r (s)	0.052	0.054	0.182	0.025
t_s (s)	1.022	0.225	0.271	0.091

(B). Experimental Performance Criterion. ____/12

Note that M_p , t_r , t_s 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
M_p (%)	56.16%	2.82%	0.00%	4.82%
t_r (s)	0.048	0.060	0.257	0.031
t_s (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
M_p (%)	54.85%	5.389%	0.189%	6.74%
t_r (s)	0.042	0.046	0.185	0.032
t_s (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
M_p (%)	unstable	18.12%	1.60%	12.5%
t_r (s)	unstable	0.046	0.144	0.028
t_s (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 M_p , t_r , and t_s)?

Section 3 has larger overshoot, smaller rise time and larger settling time.

They should be different, as the friction is compensated in 3, which makes 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 K_p .

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 E_{ss} ____/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 K_p would lead to lower steady state error. In PID control, a higher K_i would minimize steady state error significantly.

Part 4. ____/12

Friction Values

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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

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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.