Report By:

Lab Partner:

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Section:

# Prelab 3 \_\_\_/45

You do not have to use this template, but it does show how we will grade the prelab and gives some hints for this lengthy assignment

## (A). All-integrator block diagram \_\_/4

If you’d like to make your all-integrator block diagrams in Simulink, you may. I changed the background color of the blocks belonging to the torque motor red and those in the tape dynamics blue so that their grouping would be obvious. These images below are purposely blurred – you’ll have to do your own work



I rearranged the block diagram below so that the disturbance torque is in the top left. This helps to show what the forward path and feedback loop are when considering the transfer function from the disturbance torque to the output. You do not need to do this, but it simplifies finding the equations.



## (B). Transfer functions \_\_/6

Hint: remember to make the denominators of your transfer functions *monic*. A *monic* polynomial has 1 as the leading coefficient. This will simplify your math.





## (C). For what values of K are the closed-loop systems stable?

Hint: Notice the denominators of each function. ***\_\_/3***

For , the closed loop is stable when K is

For , the closed loop is stable when K is

## (D). Controller 1. What K regulates the response to a step disturbance input to ≤ 0.01 rad/s? \_\_/3

Use the Final Value Theorem, (page 93, FPE)

K is

## (E). What Kr (in terms of K) regulates the response to a step input to 1? \_\_/3

Use the Final Value Theorem, (page 93, FPE), and set the desired result to 1. *Put the result in simplest form.*

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## (F). What are the closed loop values of ζ and ωn? What are the Mp, ts and tr? \_\_/5

ζ = 1 pt

ωn= 1 pt

Mp = 1 pt

ts = 1 pt

tr = 1 pt

## (G). Controller 2: Set ζ to 0.75 to achieve low overshoot. What are the new K, ωss and Mp? Can we achieve both our goals? \_\_/8

K = 2 pts

ωss= 2 pts

Mp = 2 pts

Can we achieve both goals? 2 pts

## (H). Add derivative feedback. Find the new transfer functions. For what ranges of K and Kd is the closed-loop system stable? \_\_/6

The new transfer functions:

 2 pts

 2 pts

For what ranges of K and Kd is the closed-loop system stable? 2 pts

*Hint – solve for K first. Using Routh Criterion gives a clean answer*

K must be:

K\*Kd must be:



Rearranged so that the input is :



## (I). Controller 3: Select K and Kd such that part (d) is satisfied and ζ is 0.75. \_\_/7

K = 2 pts

Kd = 2 pts

Check: is ωss= 0.01 rad/s?

Mp 1 pt

tr 1 pt

ts 1 pt