Report By:

# Total \_\_\_/45

Lab Partner:

Lab TA:

Section:

## Part 1. \_\_\_/15

### Plots \_\_\_/6

*(Attach time response plots to end or include them here)*

*A screen shot of a computer

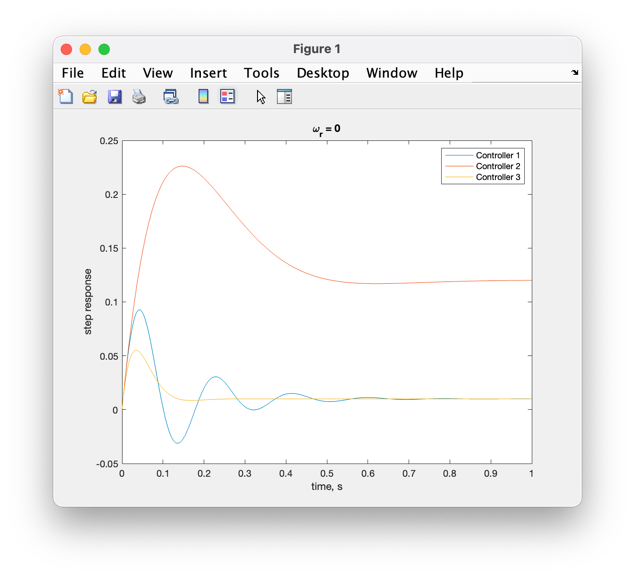
Description automatically generated*

Fig. 1 Fig. 2

### Time Response to a Unit step for ωr \_\_\_/6

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Controller 1** | | **Controller 2** | | **Controller 3** | |
| **Prelab** | **Lab** | **Prelab** | **Lab** | **Prelab** | **Lab** |
| **Mp (%)** | % | % | % | % | % | % |
| t­r (s) |  |  |  |  |  |  |
| t­s (s) |  |  |  |  |  |  |
| K |  | |  | |  | |
| Kr |  | |  | |  | |
| Kd |  | |  | |  | |

Table 1

### Compare/contrast \_\_\_/3

* *Mp, tr, and ts from Prelab with those from Lab*
* *Which controllers met the specifications?*

## Part 2. \_\_\_/12 Deriving ess components

*For the system in Figure 3.1, derive the relationship between steady-state error (ess= ωr – ω) and natural frequency, ωn. Consider the error as a function of both ωr and τd, and model these as step inputs. Since the system is linear, superposition allows the two components to be calculated separately and then summed. Notice that ess is not the same thing as “e” in the block diagram (e= Kr ωr – ω).*

 *(as an expression of K)*  (1)

*(as an expression of ωr and τd)* (2)

*Hint: Use the Final Value Theorem, (page 93, FPE). Make sure you answer the following questions:*

*ess due to a step in ωr (τd = 0) is:*

*To minimize this error component, should be….*

*ess due to a step in τd (ωr = 0) is:*

*To minimize this error component, should be….*

## Part 3. \_\_\_/18

### For controller 3, derive the relationship between ζ, *ωn*, and the gains K and Kd. \_\_\_/12

 (3)

 *(as an expression of K and Kd)* (4)

 *(as an expression of K and Kd)*  (5)

*Discussion: Increasing K does what to ωn2, what to ζ*

*(and at what rate: linearly, exponentially, as K2, etc.)*

*Increasing Kd does what to ωn2, what to ζ*

*(and at what rate)*

### Using these equations, show how the pole locations change as Kd>0 increases in value. \_\_\_/6

Poles = *(as an expression of ζ and ωn)* (6)

*Discuss: As Kd grows, the poles move…(remember there are two components of this, depending on the damping)*