

MECHTRON 4AA4

Lab #5 – L03



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# **Part 1: Schematic of completed PID controller:**

Diagram

Description automatically generated

# **Part 2: Table of Kp, Ki, Kd with overshooting and final value:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| # | Kp | Ki | Kd | Overshoot Value | Overshoot Percent [%] (approx.) | Final Value (Steady State Value) at 0.1 second | Stable (Yes/No) |
| 1 | **5** | 0.0000001 | 0 | 1.1700 | 80.91 | 0.6536 | Yes |
| 2 | **5** | 0.0001 | 0 | 1.1710 | 80.91 | 0.6544 | Yes |
| 3 | **5** | 0.01 | 0 | 1.2070 | 65.83 | 0.7633 | Yes |
| 4 | **5** | 0.1 | 0 | - | - | - | No |
| 5 | **9.5** | 0.1 | 0 | 1.4430 | 195.60 | 0.7856 | Yes |
| 6 | **5** | 0.2 | 0.01 | 0.8521 | 8.15 | 0.7847 | Yes |
| 7 | **5.5** | 0.25 | 0.02 | 0.7949 | 1.53 | 0.7864 | Yes |
| 8 | **5.6** | 0.275 | 0.025 | 0.8080 | 2.58 | 0.7848 | Yes |

**Part 3: Final Motor Angle Result:**

## Final K values used:

|  |  |  |
| --- | --- | --- |
| Kp | Ki | Kd |
| 5.6 | 0.275 | 0.025 |

Motor Angle plot shown below:

**A screenshot of a computer

Description automatically generated with medium confidence**

**Part 3: Explanation:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Kp | Ki | Kd | Explanation |
| 1 | **5** | 0.0000001 | 0 | With the given default values, the system had steady state error due to the condition of DC gain being equal to zero.  Here, integrator value has negligible effect as its value is too small.  Only Kp,value influences the system. |
| 2 | **5** | 0.0001 | 0 | Purpose of adding an integral gain is to diminish the steady state error. However, integral gain value can negatively affect the overshoot percentage. At this integral gain level, system is indistinguishable from system in #1. |
| 3 | **5** | 0.01 | 0 | With a relatively large value of Ki (in comparison to #1), we start to witness reduction in steady state error. As can be seen from the previous table, this level of integral value significantly improves the steady state error. Care should be taken to as we feed the error value to the system because it negatively affects other performance parameters such as overshoot percent and settling time. |
| 4 | **5** | 0.1 | 0 | This integral value makes the system unstable because of the integral operation of large error values as the gain is high in this case. |
| 5 | **9.5** | 0.1 | 0 | In this case, system can be pushed to stability at 0.1 integral gain by raising the Kp value. |
| 6 | **5** | 0.2 | 0.01 | Adding a derivative also improves the stability factor as integrals’ pole affect is canceled by the derivatives’ zero if they are close to one another. In this case, derivative gain offers positive change in the system’s transient behavior i.e., rising time is improved. |
| 7 | **5.5** | 0.25 | 0.02 | Now, the proportional, integral and derivative gains bring the system to acceptable conditions by improving settling time, overshoot, and rising time values. |
| 8 | **5.6** | 0.275 | 0.025 | These values give desired outcome; however, these gain values are not unique. |

In essence,

P works on the present value of the system,

I deals with the past error values of the system, and

D predicts the future of the system.