Recommended Assessment

Steady State Error

Calculating the Steady State Error due to a Step Input

1. Find the closed-loop transfer function $\frac{E(s)}{R(s)}$ that represents the dynamics between the desired position, $R(s) = \Theta(s)$ and the error, $E(s) = Y(s) - R(s) = \Theta_m(s) - \Theta_d(s)$ when using PID control $U(s) = (k_p + \frac{k_i}{s})E(s) - k_d Y(s)$).

2. Find the error transfer function $E(s)$ for the step reference input $R(s) = \frac{R_0}{s}$.

3. Calculate the amount of steady state error in the system when using a PD controller (that is, $k_i = 0$). What is the system type?

Finding the Steady State Error due to a Step Input from Experiments

4. Using the screenshot of the position scope for the PD controller with a step input, what is the steady state error of the system?

5. Comparing the experimental and calculated steady state error, are they the same? If not, please give one reason why there is a difference.

Calculating the Steady State Error due to a Ramp Input

6. Find the error transfer function for the ramp reference input $R(s) = \frac{R_0}{s^2}$ when using a PID controller with the derivative gain applied to the output.

7. Calculate the Steady State Error due to the ramp input when using a PD controller (that is, $k_i = 0$).

8. Use system parameters K, R_0, k_p, k_d to compute Steady State Error due to the ramp input when using a PD controller.

9. Calculate the Steady State Error of the system due to a ramp input when using a PID controller. Comment on the effects of adding integral control.

10. What is the System Type for the PD and PID controlled systems?

Finding the Steady State Error due to a Ramp Input from Experiments

11. Using the measurement tool in the scope, obtain and write down the steady state error in the system using PD control. Are the experimental and calculated values (from Question 8) the same? If they are not, give one reason why there is a difference.

12. Using the position scope for the ramp input with PID control, calculate the steady state error. Does the response behave as expected? Approximately how long does it take to reach steady state?

13. Write down the final PID controller gains used and explain the thinking behind the choices of these gains.