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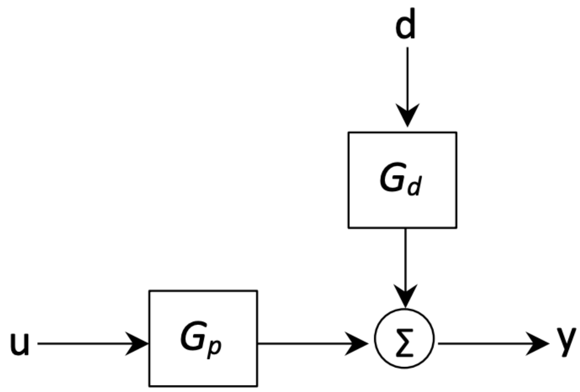
CHE381 Lab Exam



$G_p = \frac{Ke^{-\theta s}}{\tau s+1}$, $G_p = \frac{Kde^{-\theta ds}}{\tau ds+1}$

We need to design a PID controller with the integral time $\tau_I = \tau$ and the derivative time, τ_D, adjusted to maximise K_C, where we have to choose K_C for a maximum closed-loop log modulus (L_{CL}^{MAX}) of 2dB.

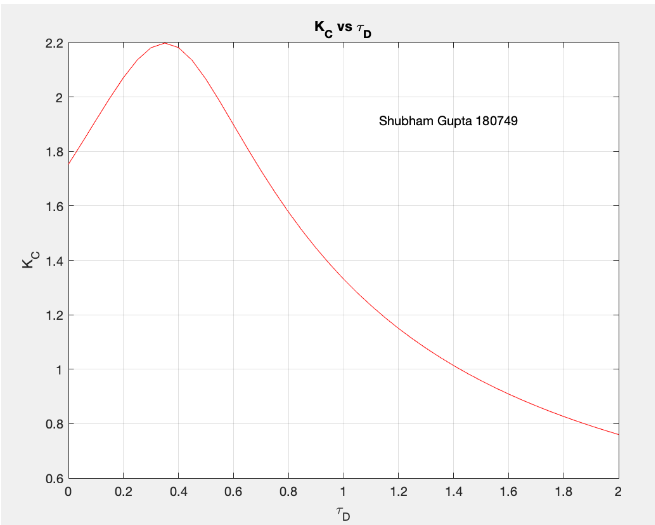
Given:
- $K = 2$
- $\tau = 1$ min
- $\theta = 5$ min
- $K_d = -2$
- $\tau_d = 2$min
- $\theta_d = 8$ min

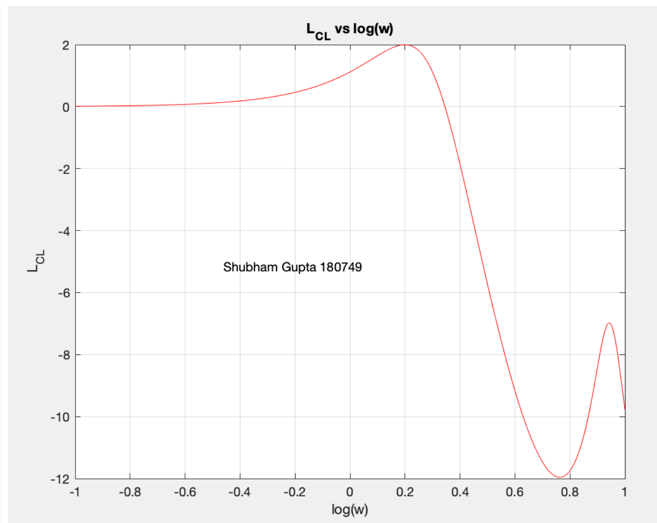
Then we need to obtain K_C and τ_D and Plot the variation in K_C with τ_D to clearly show the maximum in K_C and the corresponding τ_D value. We also need to plot L_{CL} vs log(ω) to show the LCLMAX peak clearly.
Finally, we need to plot the servo and regulator unit step responses using the PID controller and compare them with a PI controller with $\tau_I = \tau$ and K_C adjusted for L_{CL}^{MAX} = 2dB.

For PID control

We first need to assume K_C and then go about iterating in a loop with varying ω. For each iteration, we check if the value of $20\log_{10}(G_{CL})$ is equal to two. If yes, we break the loop and report the corresponding K_C. If no, we shift our K_c to positive/negative according to the value of L_{CL} obtained and run another iteration and do as done above.

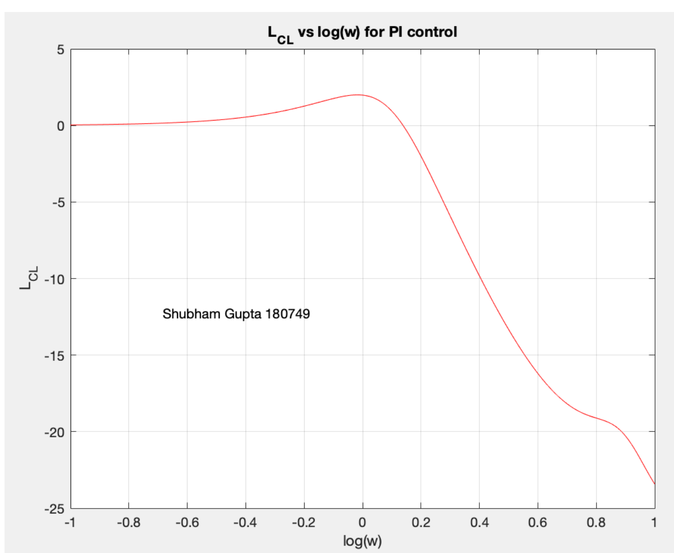
The optimal K_C obtained can be checked while drawing K_C vs τ_D, and τ_D will be at maximum K_C.
After running the iterations, we obtain $K_C = 2.1981$ and $\tau_D = 0.35$. We will use these results for further simulations.
Following are the plots of K_C vs τ_D and L_{CL} vs log(ω) for PID control.





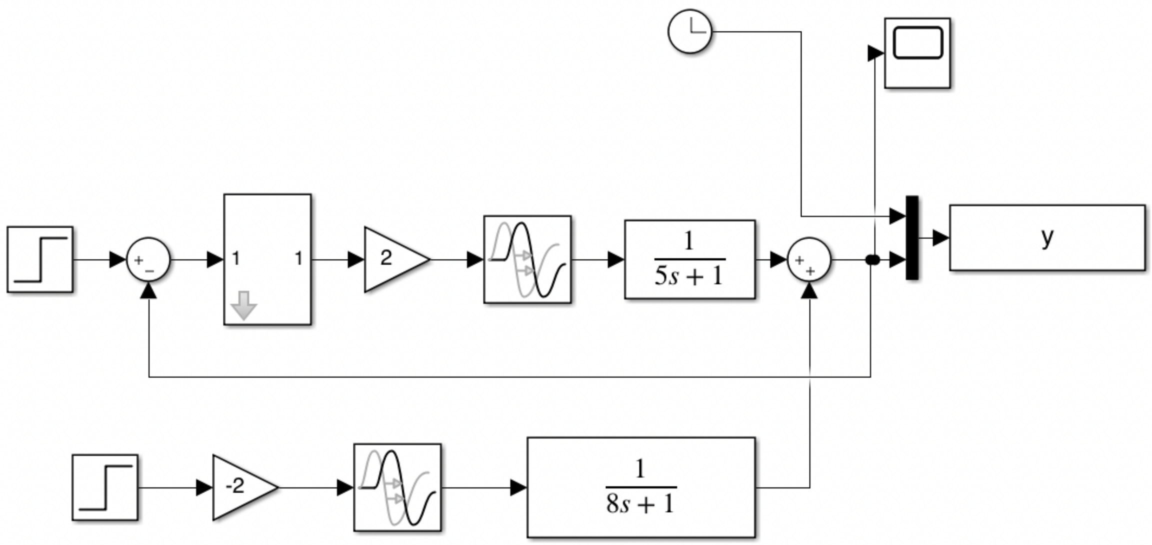
For PI control

We use the same algorithm as described above. The only difference will be in G_{OL} as we don't have to account for τ_D. After running the iterations, we obtain $K_C = 1.7527$. We will use this result for further simulations.
Following is the plot of L_{CL} vs log(ω) for PI control.



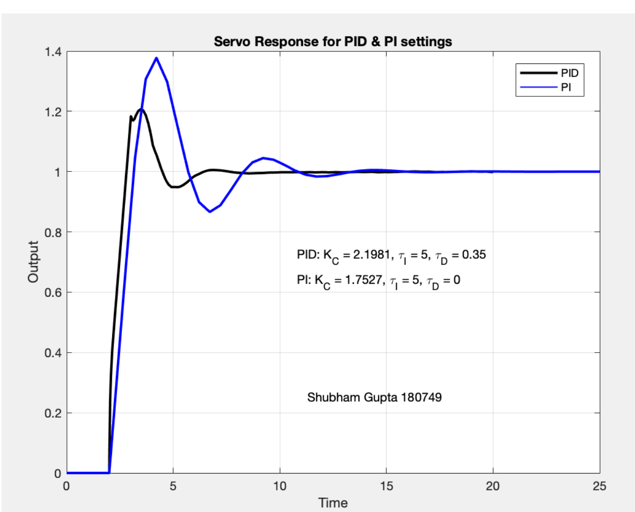
Servo & Regulator response for PID & PI control

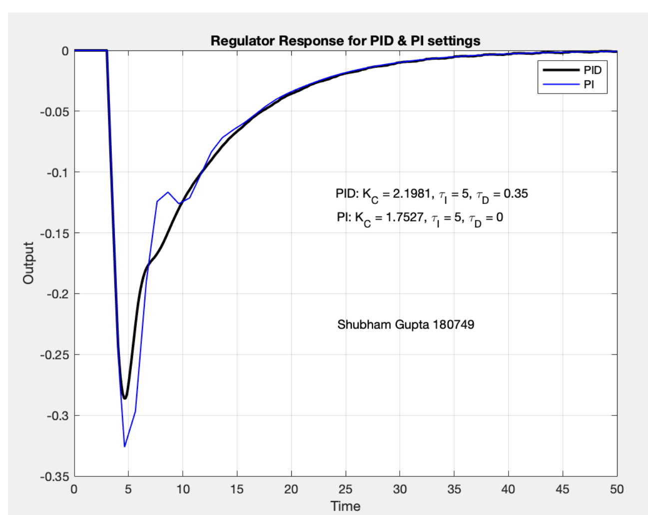
We first need to design our simulation model.



We run this simulation for servo and regulator response using the values in the following table,

	PID	PI
K_C	2.1981	1.7527
τ_I	5 min	5 min
τ_D	0.35 min	0 min





CONCLUSION

- For this particular setup, servo response works better than regulator response, and it achieves its setpoint faster than regulator response.

- We find a maximum in the plot of K_C vs τ_D, which indicate that there is only one optimal value of K_C for the PID setup. We use this K_C and corresponding τ_D for our simulations.