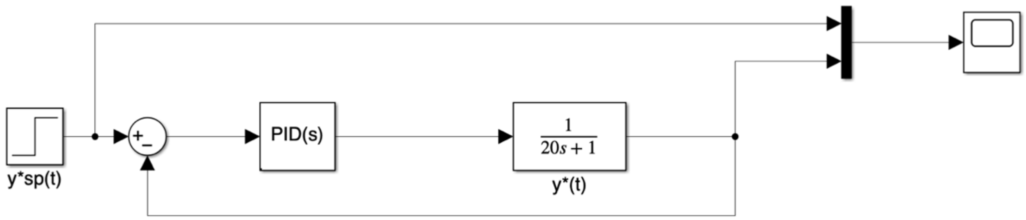
Analysis of PI Feedback Control Loop Dynamics[1]

Consider the simplified feedback control loop below.



A. (1 pt) Show (analytically) that if we use $K_{OL} > 0$, the loop is stable for all K_C-τ_I combinations.

B. (2 pts) When using a PI controller, the response y*(t) may be oscillatory for various K_C-τ_I combinations. Obtain an analytical expression that allows to delineate $\xi = 1$ in the K_C-τ_I space. Plot this equation and identify the overdamped and underdamped regions. Axis ranges: 0 to 100 for K_C and 0 to 25 for τ_I. Perform two simulations with $K_C = 10$ to confirm: one with a τ_I value leading to an oscillatory response, and the other for an overdamped response. Include the graphs in your report.

C. (2 pts) Dead times tend to make responses more oscillatory and possibly, unstable. Add a process dead time to your simulation model. Determine by trial and error the critical value, τ_I^c, under which the response becomes unstable for $K_C = 0.1$, 1.0 and 10 and $\theta = 1$, 2 and 5.

K_C	θ	τ_I^c
0.1	1	
0.1	2	
0.1	5	
1	1	
1	2	
1	5	
10	1	
10	2	
10	5	

Comment the results you obtained (all questions).

Important notes:

- You can work alone or in a team of 2. Submit a single PDF document including a cover page with your name(s) and student ID(s) on it.
- Your report must be submitted through myCourses before the due date/time.
- The TA for A5 is Arav.

[1] You can either use SIMULINK or a simple MATLAB script in this assignment.