Lab 4

Consider the following linearized representation of a chemical process:

$$\begin{aligned} \frac{d}{dt}\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} &= \begin{bmatrix} -1 & 0 & 0 \\ 1 & -1 & 0 \\ 0 & 10 & -10 \end{bmatrix}\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} U \\ Y &= [0\ 0\ 1]\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} \end{aligned} \tag{1}$$

1. Design a PID controller using the Ziegler Nichols tuning method:
   (a) Report the values of the ultimate gain and the ultimate period.
   (b) Report the values of the PID parameters computed from the ultimate gain and the ultimate period.
   (c) Show the plot of the output vs time of the system under P control with the ultimate gain (which leads to sustained oscillations).
   (d) Show the plot of the output vs time of the system under PID control using the Ziegler Nichols settings for a step change in the set-point from 0 to 1.
   (e) Can you improve this response ? Show the plot of the improved response.
   (f) Attach your MATLAB program.
2. Design a PID controller using the Process Reaction Curve method:
   (a) Show the plot of the output vs time for a step change in input from 0 to 2.
   (b) Report the values of S, S^* and θ.
   (c) Report the values of the PID parameters computed from S^* and θ.
   (d) Show the plot of the output vs time of the system under PID control using the Process Reaction Curve method settings for a step change in the set-point from 0 to 1.
   (e) Can you improve this response ? Show the plot of the improved response.
   (f) Attach your MATLAB program.

You can reuse your MATLAB program from Lab 3.