UNIVERSITY OF PORT HARCOURT
FACULTY OF ENGINEERING
DEPARTMENT OF CHEMICAL ENGINEERING

BASIC CHEMICAL STRUCTURE, ATOMS, MOLECULES, IONS

BY

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Introduction

Background study:

In the late 19th century and early 20th century, PI and PID controllers were developed to enable some devices automatically maintain stability in the presence of disturbances. The first examples of PID controllers were developed by Elmer Sperry in 1911, and his son, Laurence Sperry in 1914. Nowadays, PID temperature controllers are applied in packing industries, industrial ovens, plastic injection machinery and hot stamping machines.

Introduction

Objective:

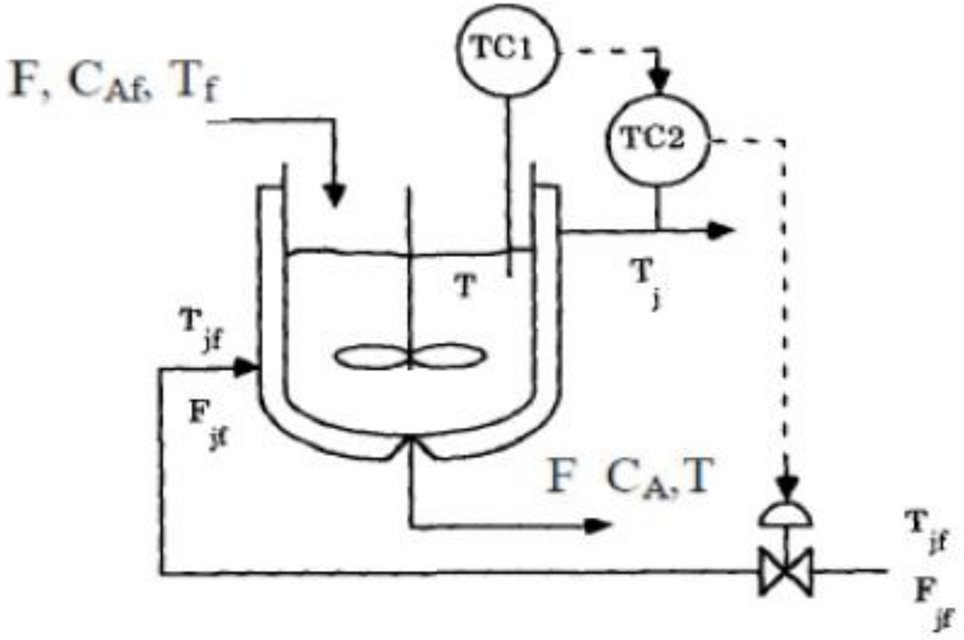
The main objective of this work is to control the temperature of a Continuously Stirred Tank Reactor (CSTR) system in the presence of a disturbance using PI and PID controllers.

Significance:

- To increase the efficiency of Control engineers and enable them choose the best controller for a process.
- To minimize the time spent in a process to get the desired result, thereby reducing cost.

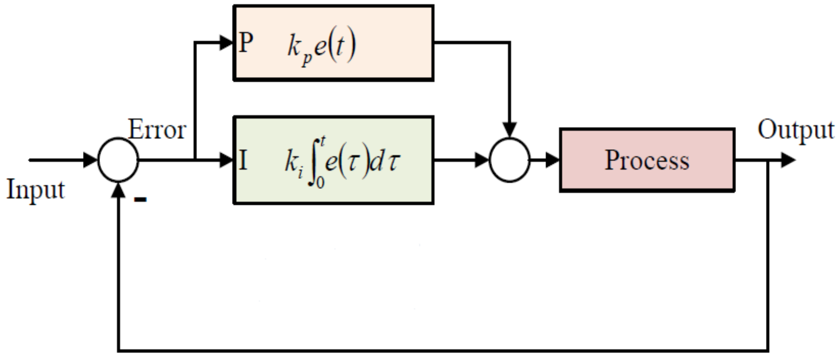
Review of Past Works

Continuous Stirred Tank Reactor (CSTR)

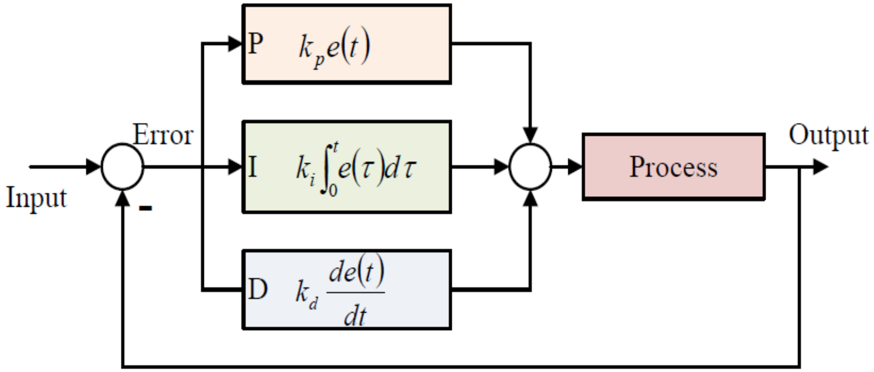


Review of Past Works

Proportional-Integral (PI) Control



Proportional-Integral-Derivative (PID) Control



Review of Past Works

Zeigler-Nichols Rules for Tuning Controllers

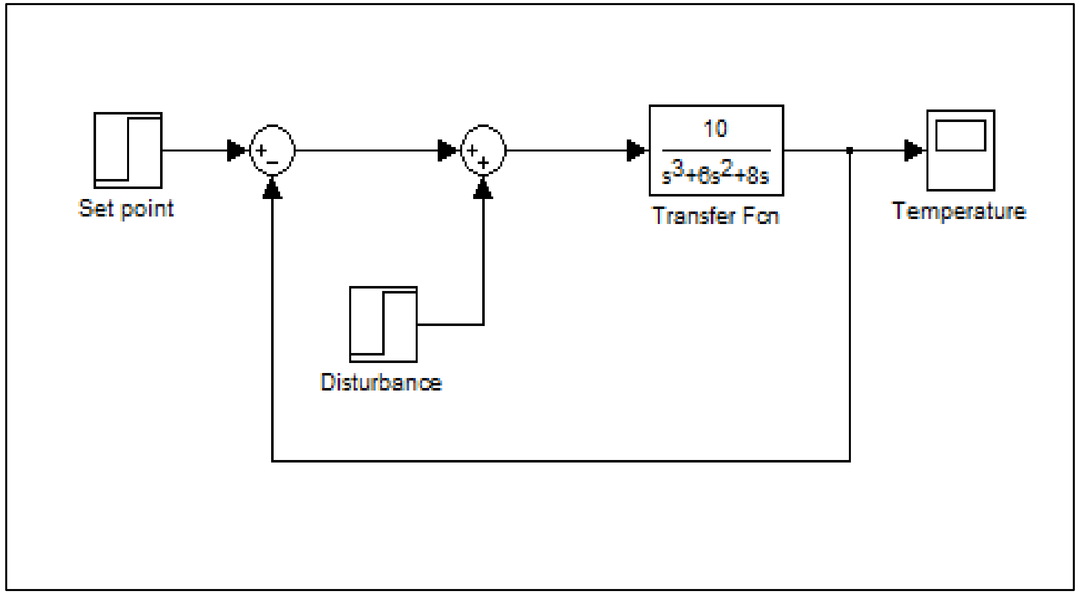
Controller	K_P	$\boldsymbol{\tau_I}$	$\boldsymbol{\tau_d}$
P	$0.5K_u$	∞	0
PI	$0.45K_u$	$0.8T_u$	0
PID	$0.6K_u$	$0.5T_u$	$0.125T_u$

$$K_I = \frac{K_P}{\boldsymbol{\tau_I}}$$

$$K_D = K_P \times \boldsymbol{\tau_d}$$

Methodology

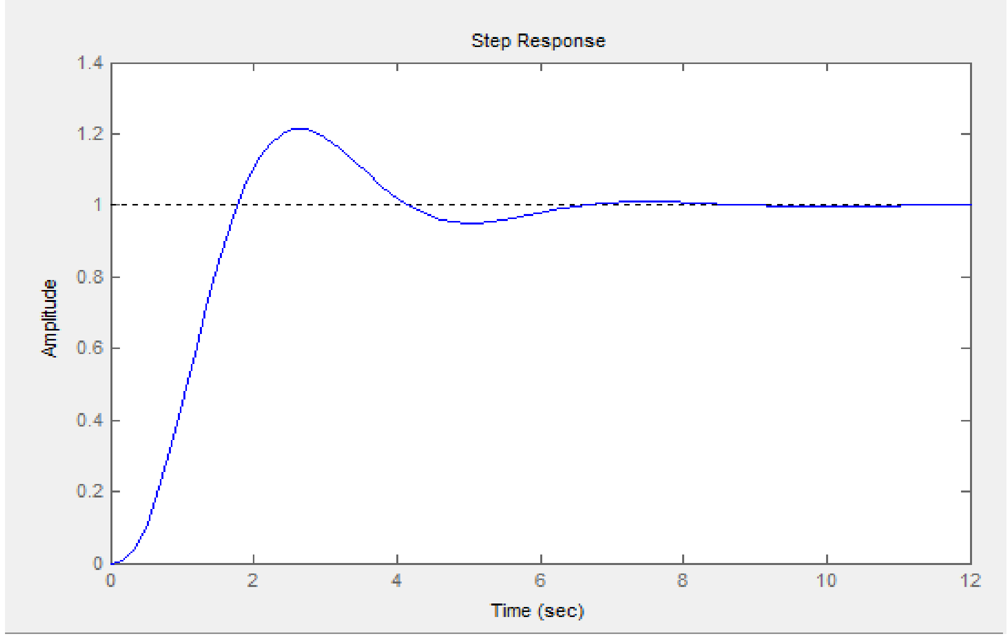
Transfer function, $G_{(s)} = \frac{10}{s^3+6s^2+8s}$



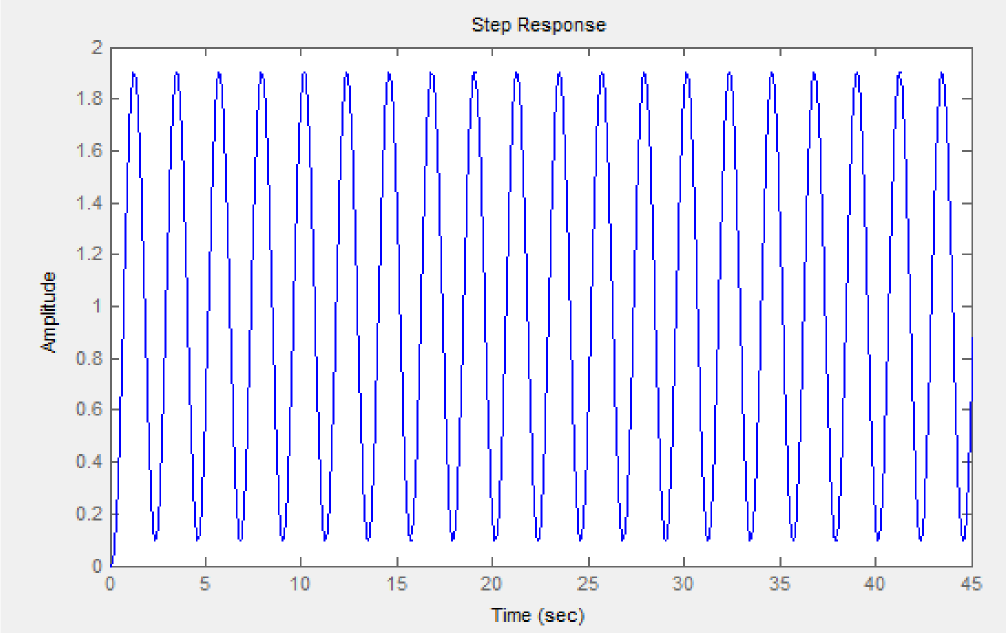
Process model

Methodology

By Trial and Error method of Sisotool in MATLAB, the Ultimate gain K_u is found when stability achieved



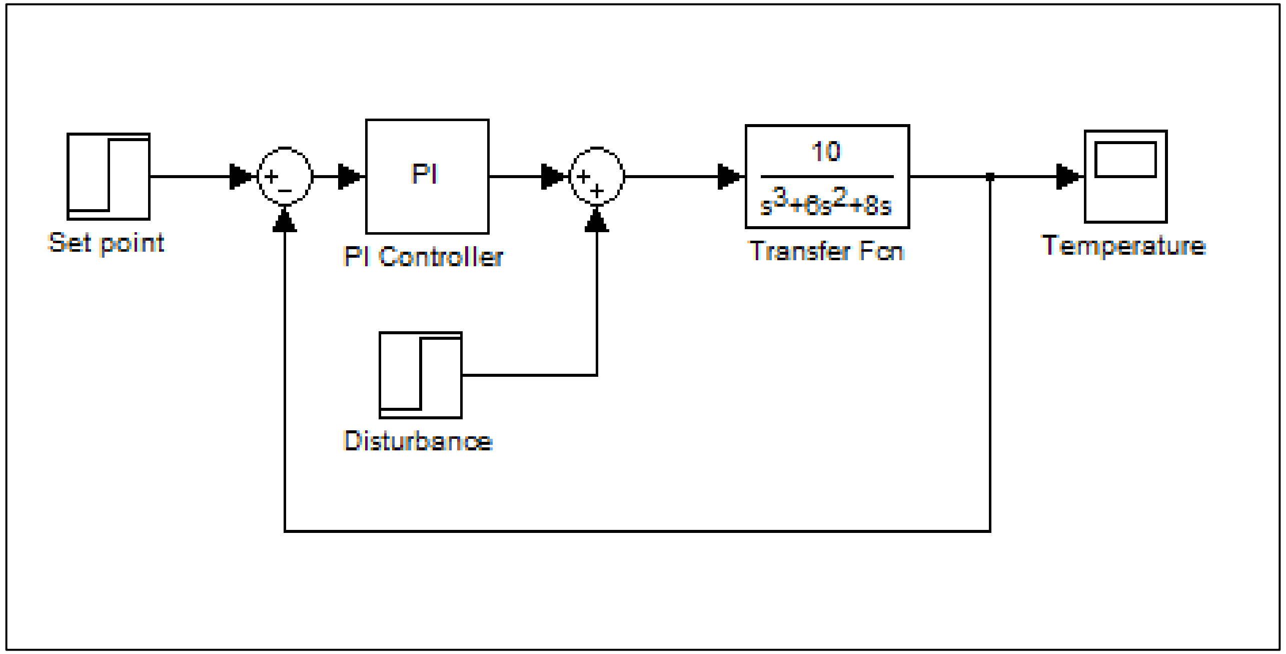
K = 1



K = 4.8

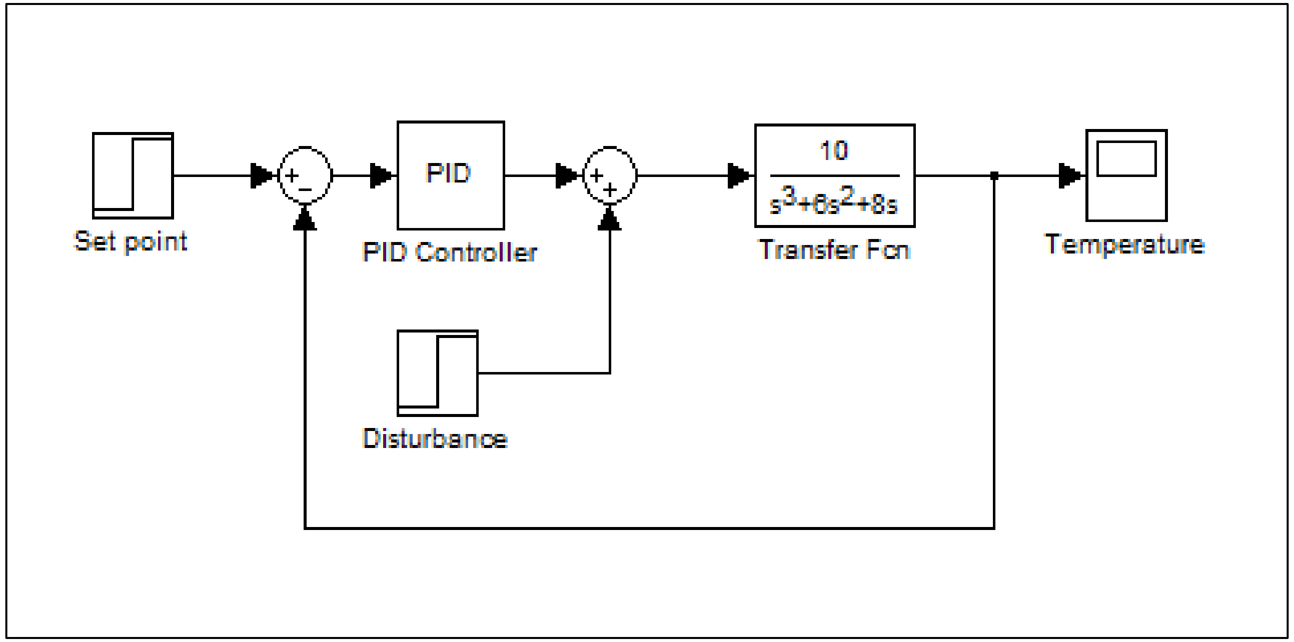
Methodology

Process model with PI Controller



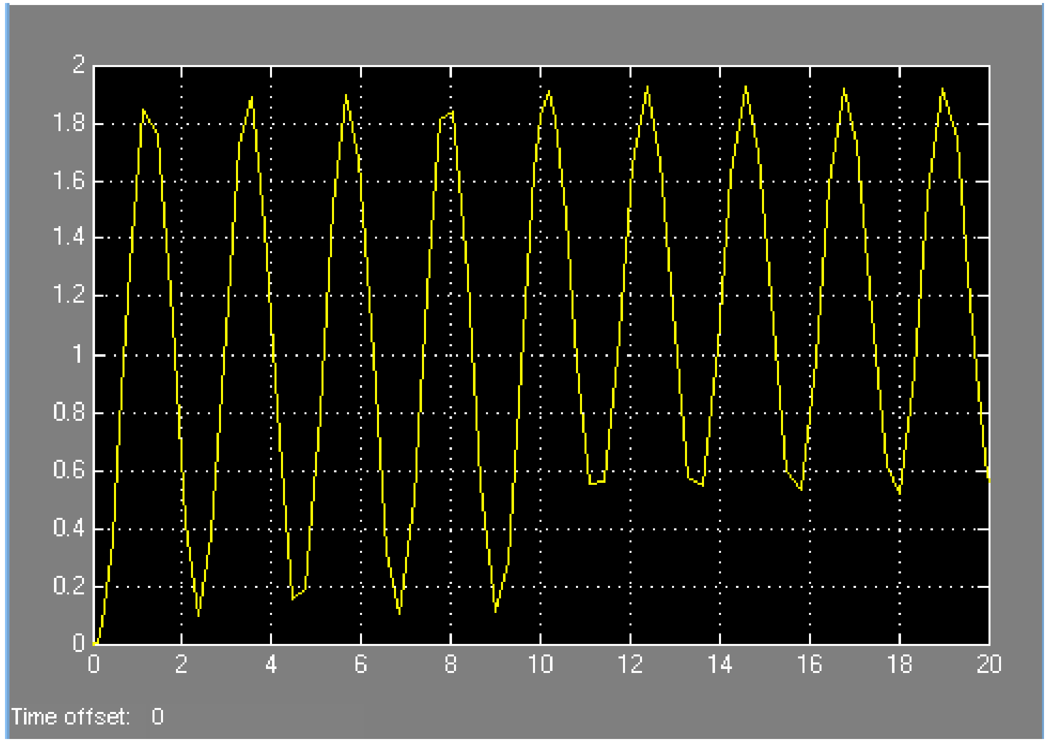
Methodology

Process model with PID Controller



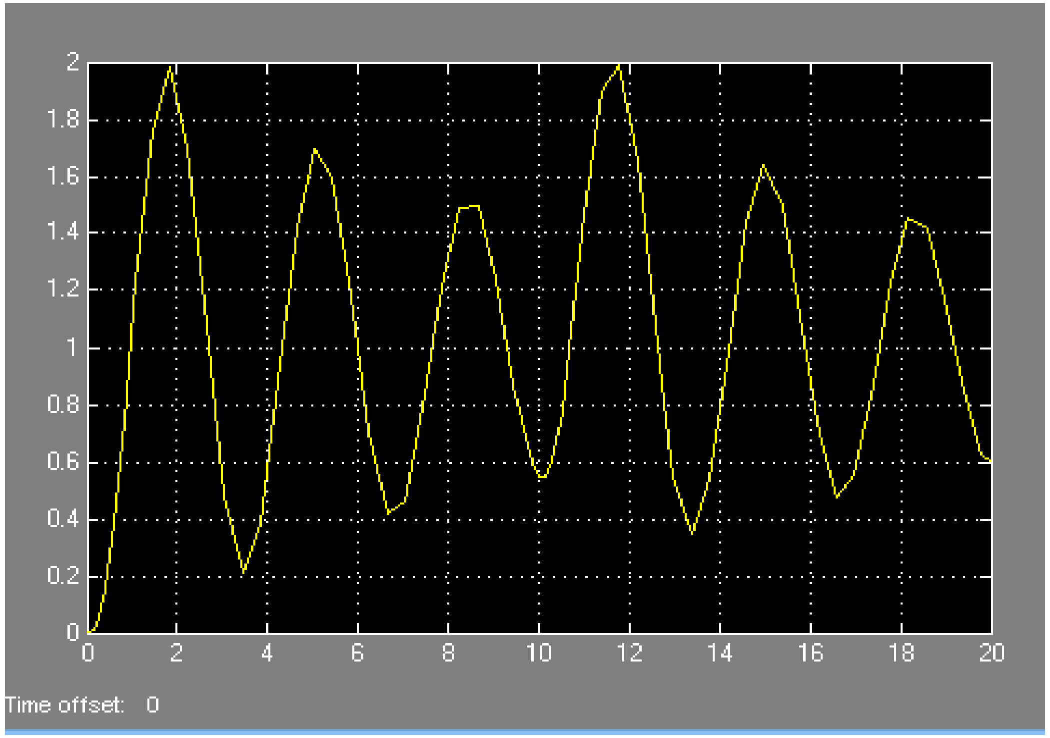
Result and Findings

Ultimate gain $K_u = 4.8$



Result and Findings

Temperature output response of Process with PI controller



For Set Point Tracking

Settling time: Ø

Overshoot: 98.3%

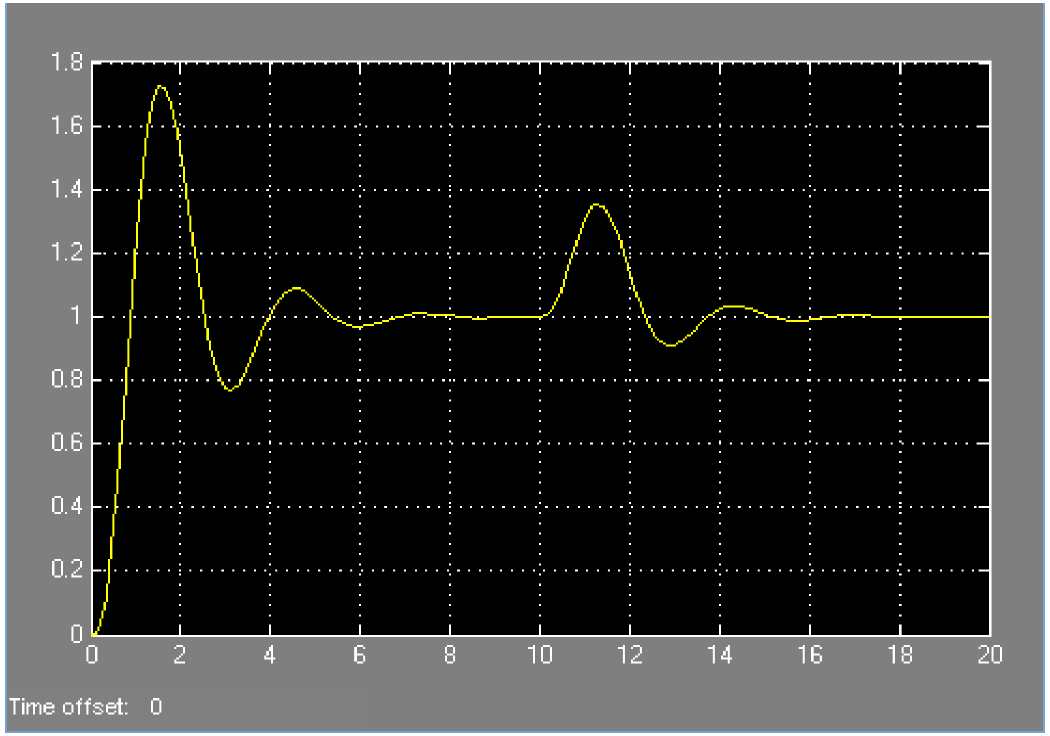
For Disturbance Rejection

Settling time: Ø

Peak deviation: 98.8%

Result and Findings

Temperature output response of Process with PID controller



For Set Point Tracking

Settling time: 6.81secs

Overshoot: 72.6%

For Disturbance Rejection

Settling time: 6.55secs

Peak deviation: 35%

Conclusions

- For PI control, Set point tracking Settling time is not feasible within the simulation time and the Peak overshoot is 98.3%. Also the Disturbance rejection Settling time is not feasible and the Peak deviation is 98.9%.
- For Set point tracking, Settling time and Peak overshoot with PID control is 6.81secs and 72.6% respectively. For Disturbance rejection, Settling time and Peak deviation is 6.55secs and 35% respectively.
- In terms of Set point tracking and disturbance rejection, the PID controller provides better settling time than the PI controller.

Recommendations

- If fast response of the system is required, it is preferable to use the PID control. Otherwise, the PI control could be used.
- Other faster controls such as Fuzzy Logic control and Cascade control can be used for faster response of the system with lesser settling time.

THANK YOU

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QUESTIONS?