# Lab Report 1(170747)

## Using PID controllers:

$$u = Kc * (e + \frac{1}{\tau_i}\int e\,dt + \tau_d * \frac{de}{dt})$$

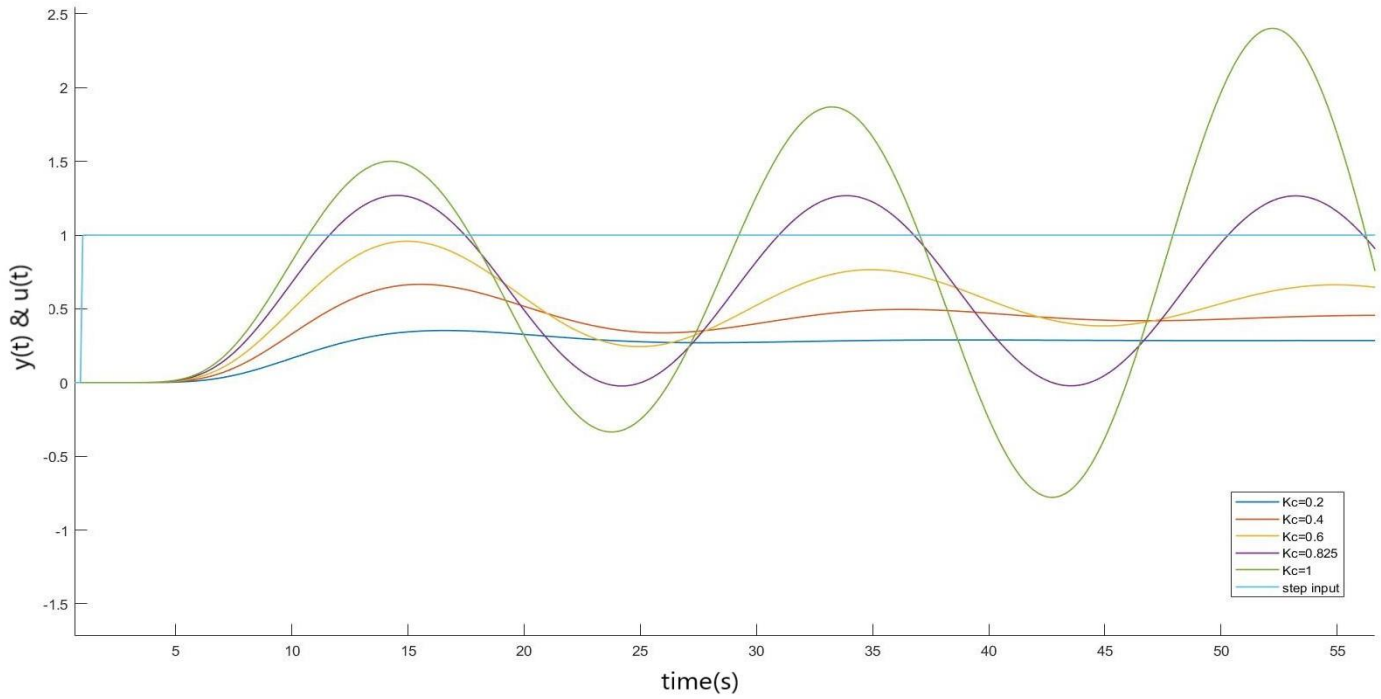
### 1. P Controller

For P controllers $\tau_i$ is set very large and $\tau_d$ is set to zero such that there is no effect of integral and derivative action.

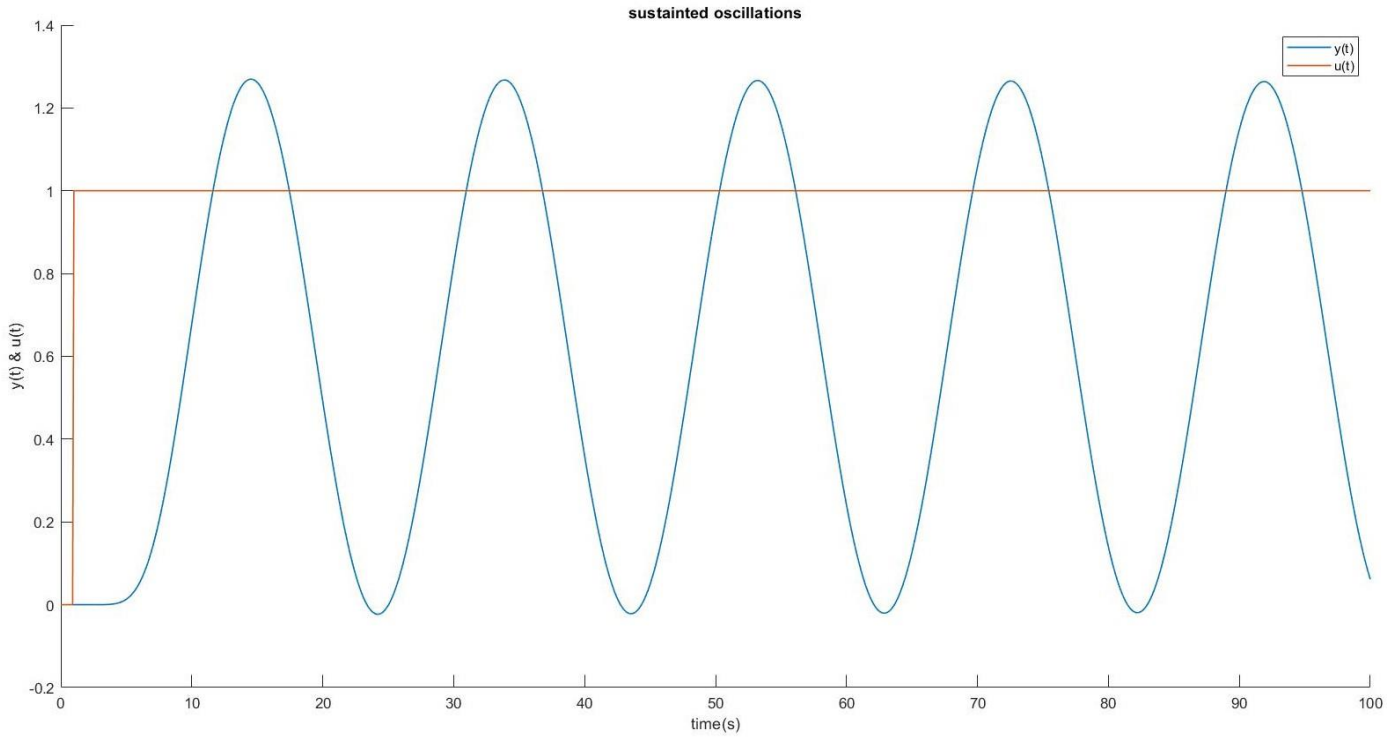
$\tau_i$ = 1e8

$\tau_d$ = 0

**For different Kc Response vs time graph is** :-

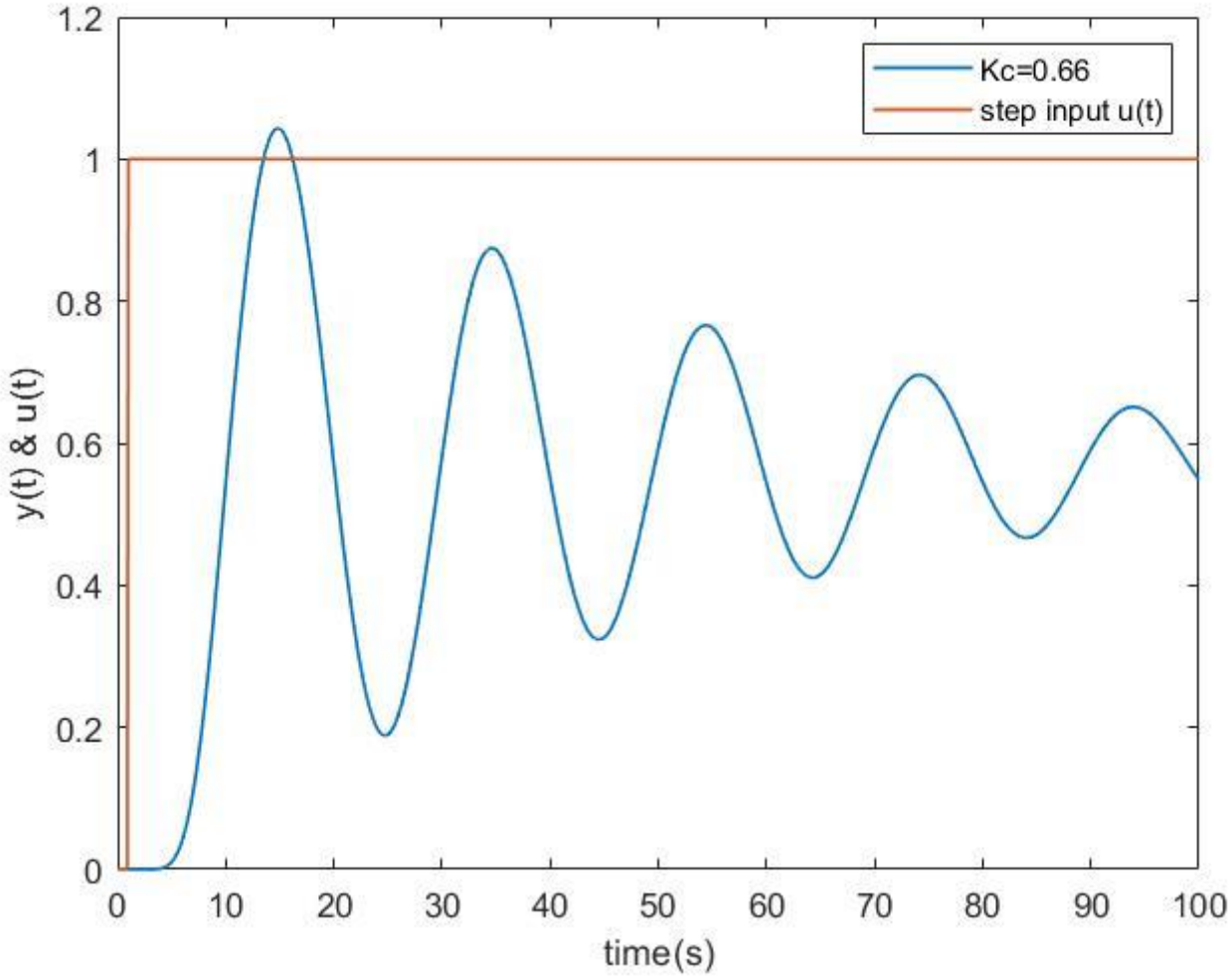


For sustained oscillations **Kc = Ku = -0.825 & Pu = 19.6 s**




For 5% overshoot **Kc=0.66**

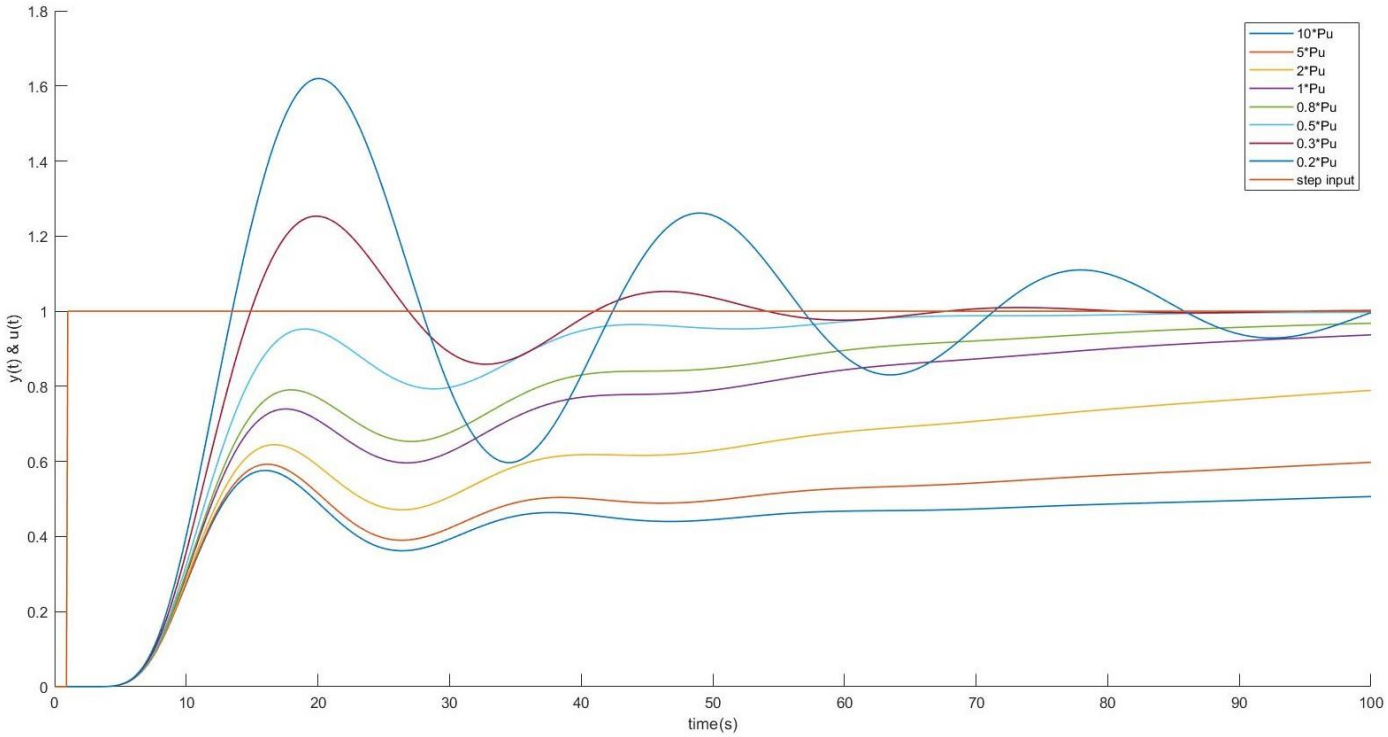
***<u>This is the recommended tuning</u>***



## 2. PI Controller

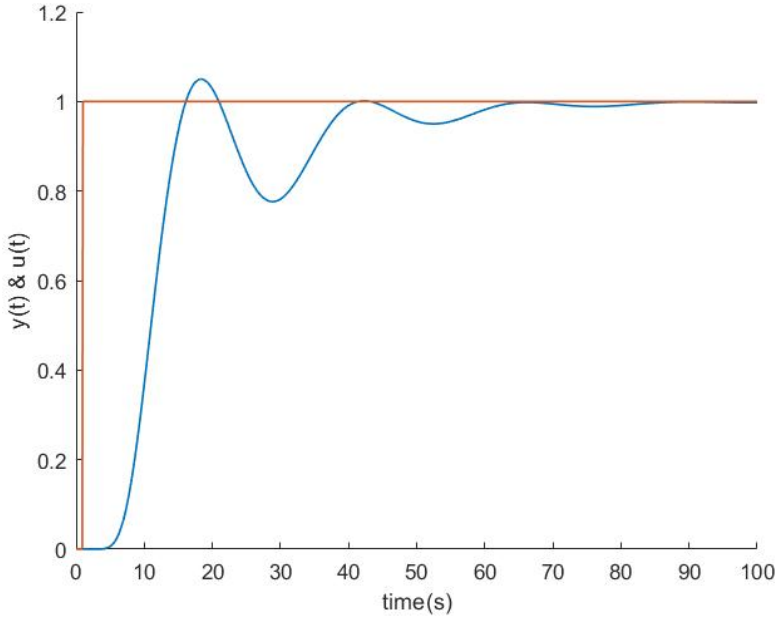
For PI controllers $\tau_d$ is set to zero such that there is no effect of derivative action.

With **Kc = Ku/2.5 = 0.33** the servo response with variation in integral time $\tau_i$ from 10Pu to 0.1Pu :-



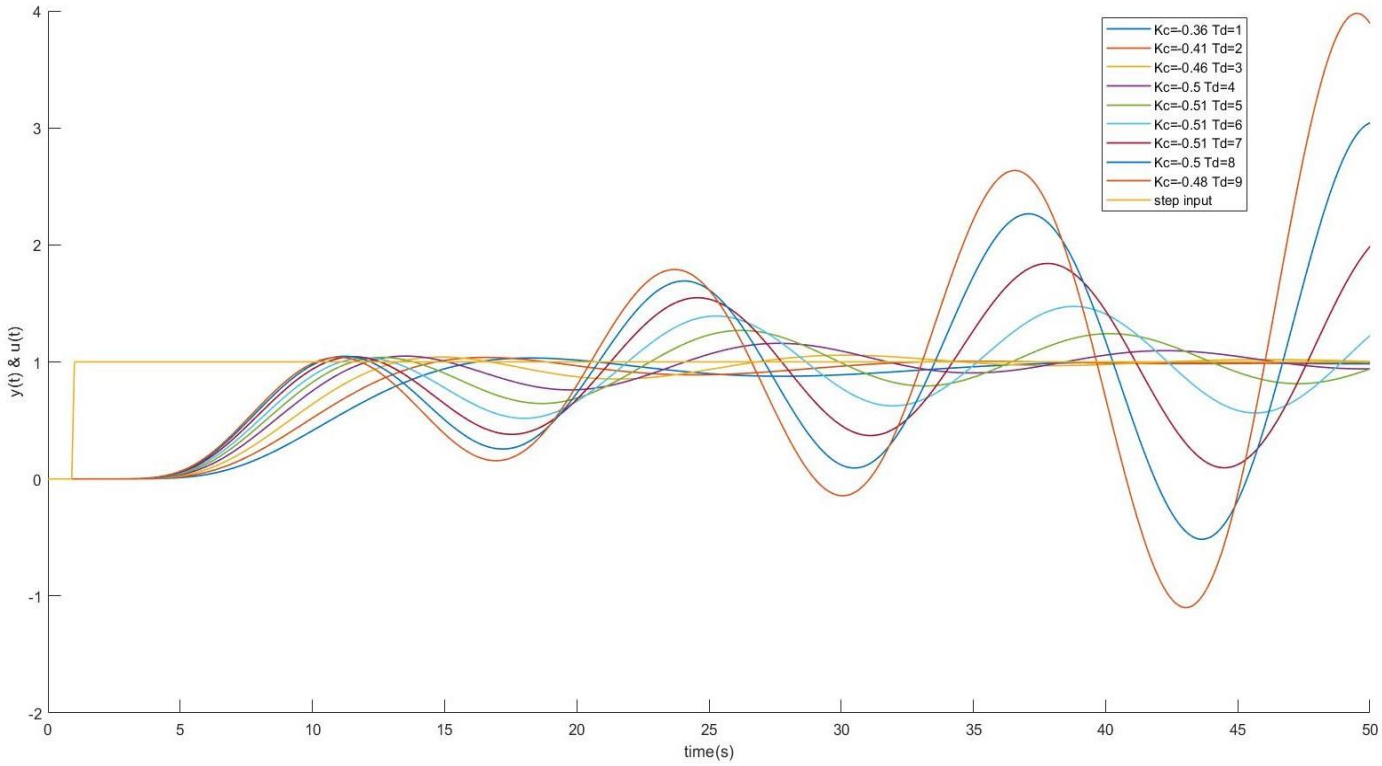

For $\tau_i$ **= 0.5*Pu = 9.8s** , 5% overshoot is obtained with **Kc = -0.375**

***<u>This is the recommended tuning</u>***



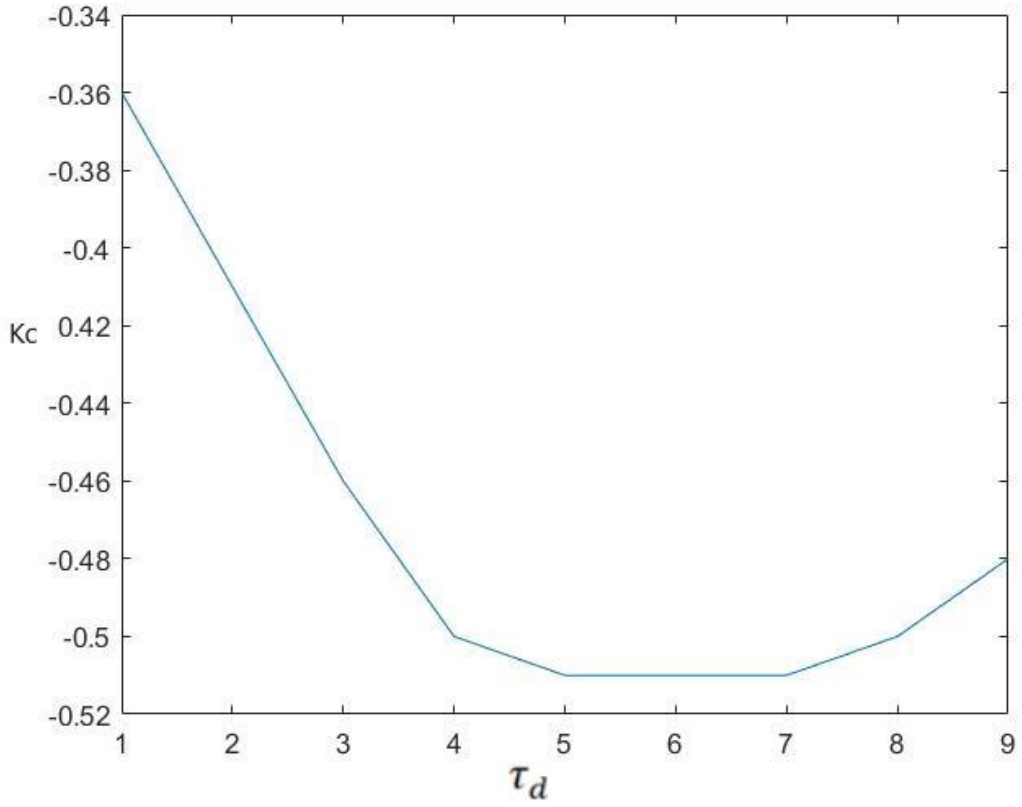
## 3. PID Controller

With $\tau_i$ = 8s , the servo response for every $\tau_d$ ranging from 0*Pu to 0.5*Pu(9.5s) Kc is adjusted such that there is a 5% overshoot




The variation of Kc vs $\tau_d$ for the above graph is :-

| $\tau_d$ | Kc |
|---|---|
| 1 | -0.36 |
| 2 | -0.41 |
| 3 | -0.46 |
| 4 | -0.5 |
| 5 | -0.51 |
| 6 | -0.51 |
| 7 | -0.51 |
| 8 | -0.5 |
| 9 | -0.48 |




The maximum value of Kc for which the response maintains stability is

Kc = -0.46

$\tau_d$ = 3s

$\tau_i$ = 8s

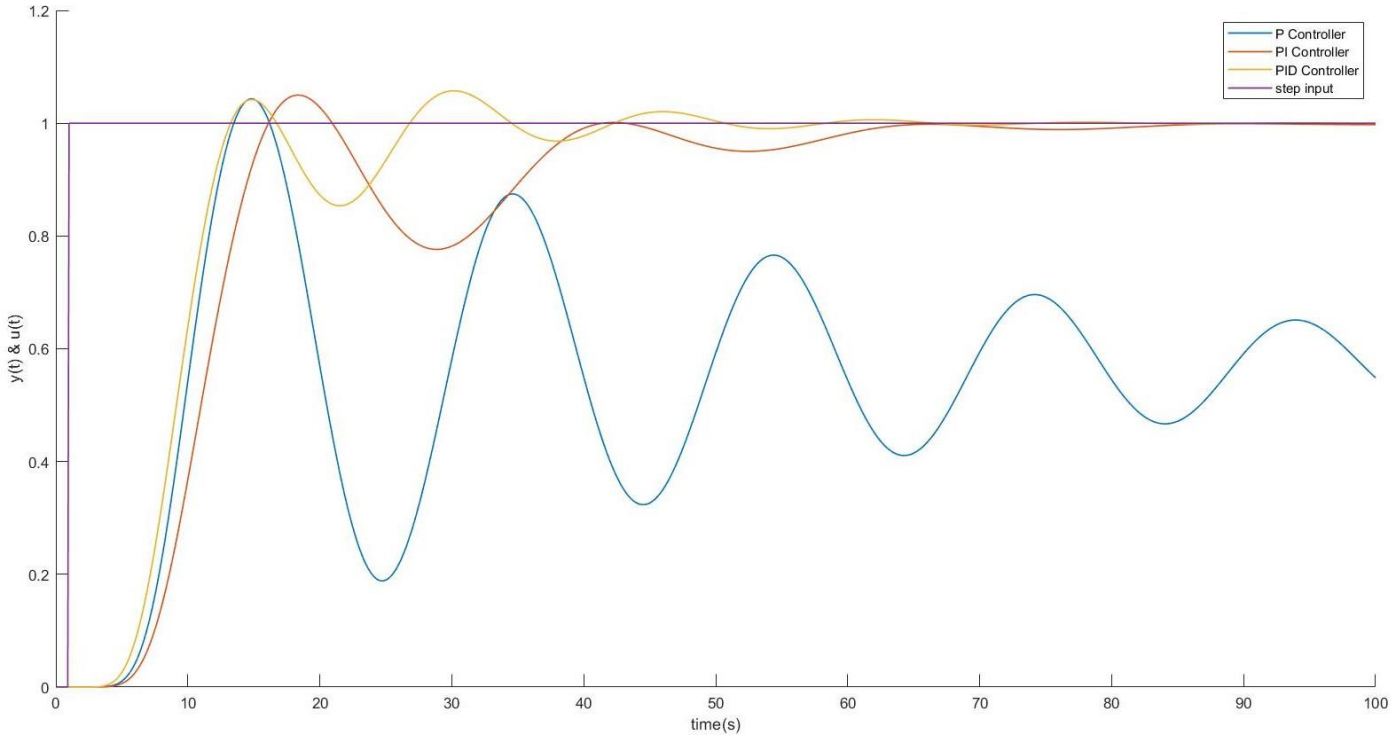
***<u>This is the recommended tuning</u>***

## Plotting Responses at recommended tuning

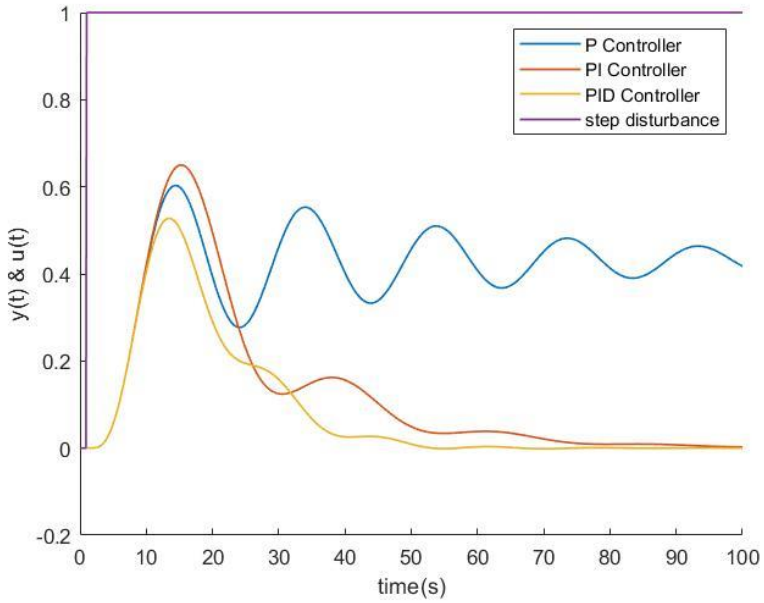
Recommended Tunings

| Type | Kc | $\tau_i$ | $\tau_d$ |
|---|---|---|---|
| P | -0.66 | 1e8 | 0 |
| PI | -0.33 | 9.8 | 0 |
| PID | -0.46 | 8 | 3 |

## Servo responses of P, PI, PID controllers on recommended tuning




## Regulator responses of P, PI, PID controllers on recommended tuning



## Using Empirical Relations for Tuning:

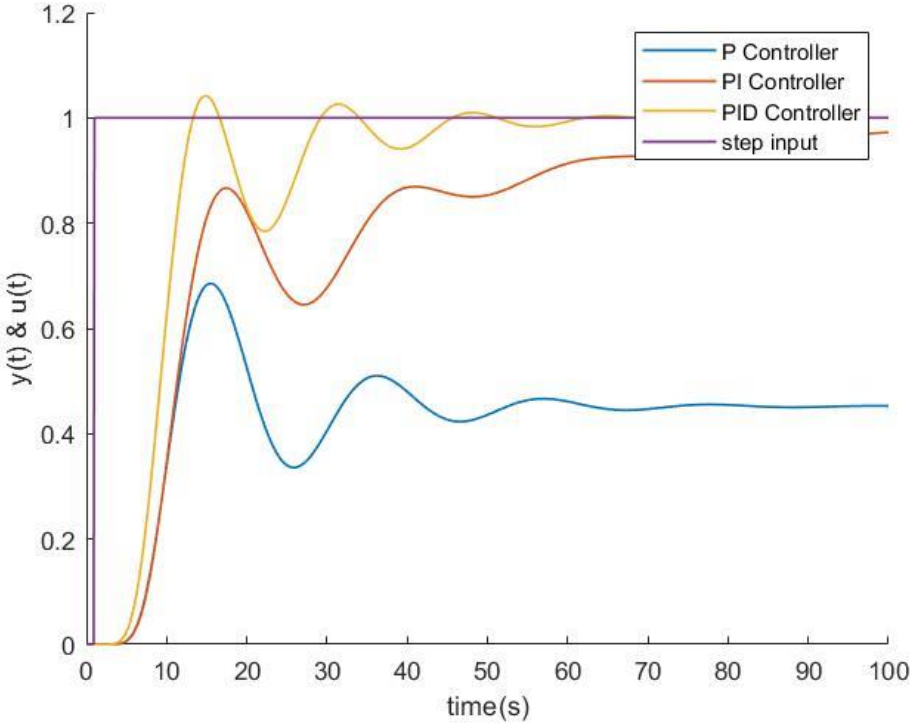
| Zeigler Nichols | Kc | | $\tau_d$ |
|---|---|---|---|
| P | Ku/2 | - | - |
| PI | Ku/2.2 | Pu/1.2 | - |
| PID | Ku/1.7 | Pu/2 | Pu/8 |
| Tyress Luyben | Kc | $\tau_i$ | $\tau_d$ |
| P | - | - | - |
| PI | Ku/3.2 | 2.2Pu | - |
| PID | Ku/2.2 | 2.2Pu | Pu/6.3 |

Ku = -0.825

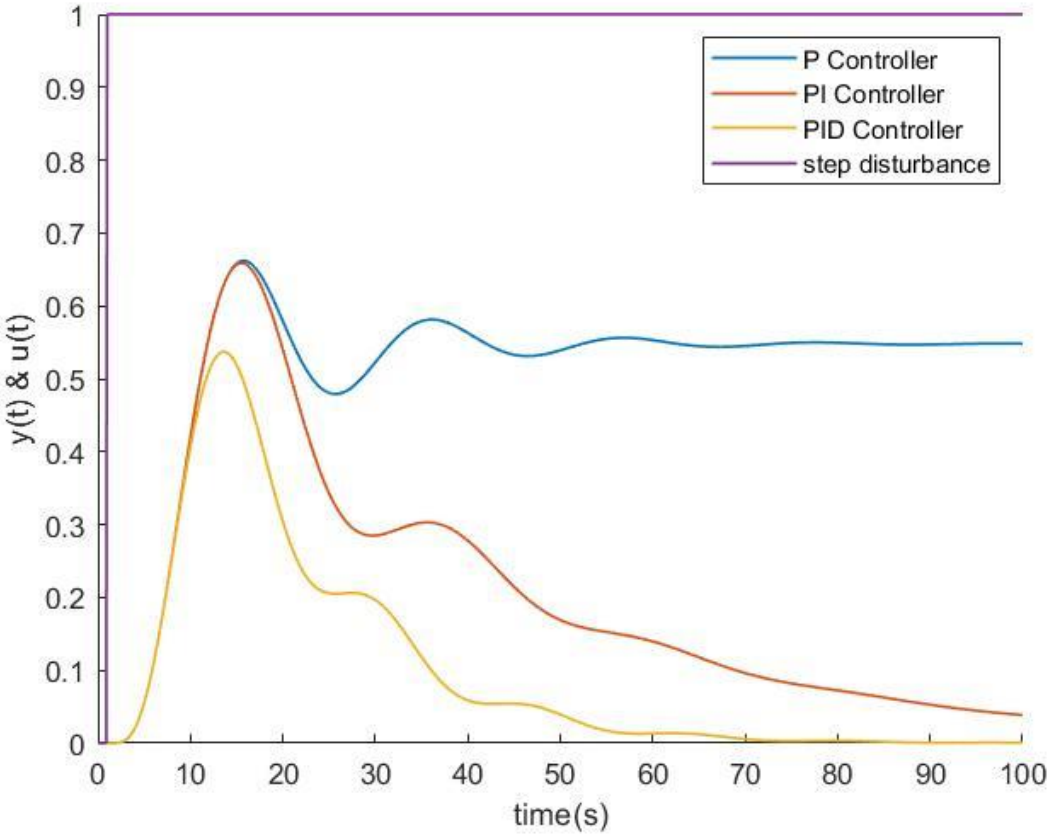
Pu = 19.3

| Zeigler Nichols | Kc | $\tau_i$ | $\tau_d$ |
|---|---|---|---|
| P | -0.4125 | - | - |
| PI | -0.375 | 16.33 | - |
| PID | -0.485 | 9.8 | 2.45 |
| Tyres Luyben | Kc | $\tau_i$ | $\tau_d$ |
| P | - | - | - |
| PI | -0.26 | 39.2 | - |
| PID | -0.375 | 39.2 | 3.111 |

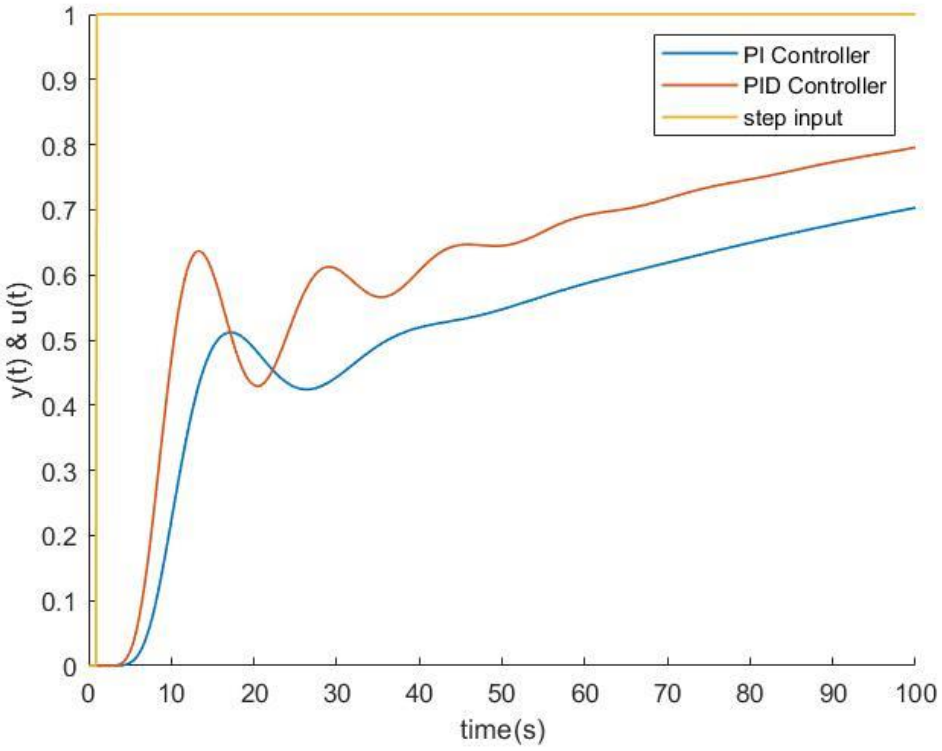
## Servo Response by Zeigler Nichols Tuning




## Regulatory Response by Zeigler Nichols Tuning



## Servo Response by T L Tuning




## Regulatory Response by T L Tuning