Experiment No : 5	Title: Tuning by Ziegler and Nichols first method

Objective:

Get an automatic tuning for the system $\frac{1}{(s+2)(s+0.5)}$ since manual tuning is hard to adjust and not available always.

Theory:

First method condition of the theory will be check in if the conditions of the first method do not qualify the system then the second method of the theory will be check in if the conditions of the second method does not qualify the system then the theory does not apply on the system .the series PID controller is to be used in this theory is differ from the parallel PID controller that used in manual tuning .

the equation of series PID controller is :

Kp(1 + $\frac{1}{Ti*s}$ + Td*s)

The conditions of first method for Ziegler and Nichols theory

1- Response of the system in open loop to step input exhibit an S shaped curve

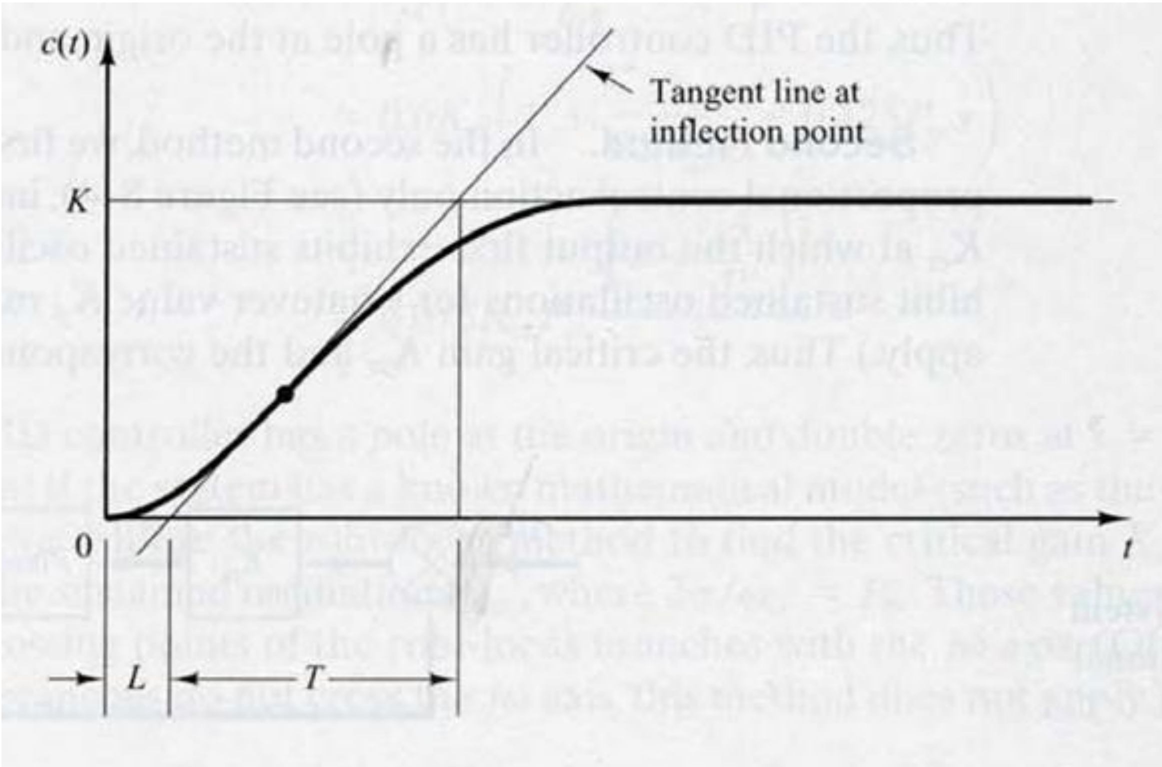
2- The system order from two to above

3- The denominator does not contain Integration (s)

4- The roots of the denominator does not contain complex (imaginary +real) just

First method theory:

Draw a tangent at the Inflection point of the curve, and then find the values of T and L as the figure below:



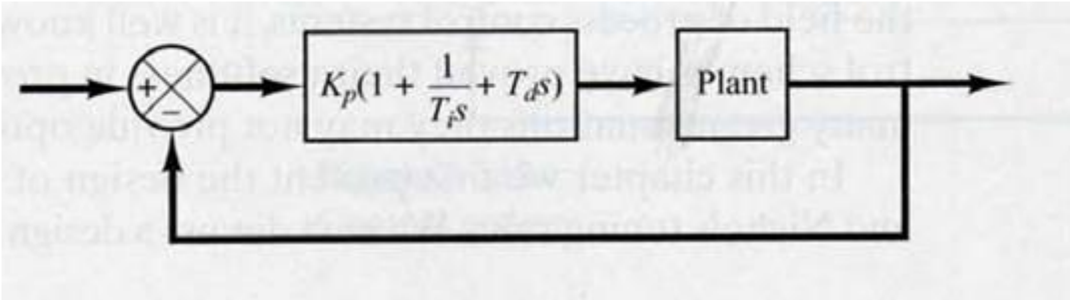
The L represents the value from 0 to the intersection of tangent with x- axis

The T represents the value from L to intersection of tangent with final value Yss

Then compensate the values of T and L in the table below

Type of Controller	K_p	T_i	T_d
P	$\frac{T}{L}$	∞	0
PI	$0.9\frac{T}{L}$	$\frac{L}{0.3}$	0
PID	$1.2\frac{T}{L}$	$2L$	$0.5L$

Then compensate the values of Kp and Ti and Td in the figure below:



The first row represents the response due to P controller

The second row represents the response due to PI controller

The third row represents the response due to PID controller

Equipments:

1) Step (from ‘source’)

2) Ramp (from ‘source’)

3) Transfer fun. (From ‘continuous’)

4) sum (from ‘commonly used block’)

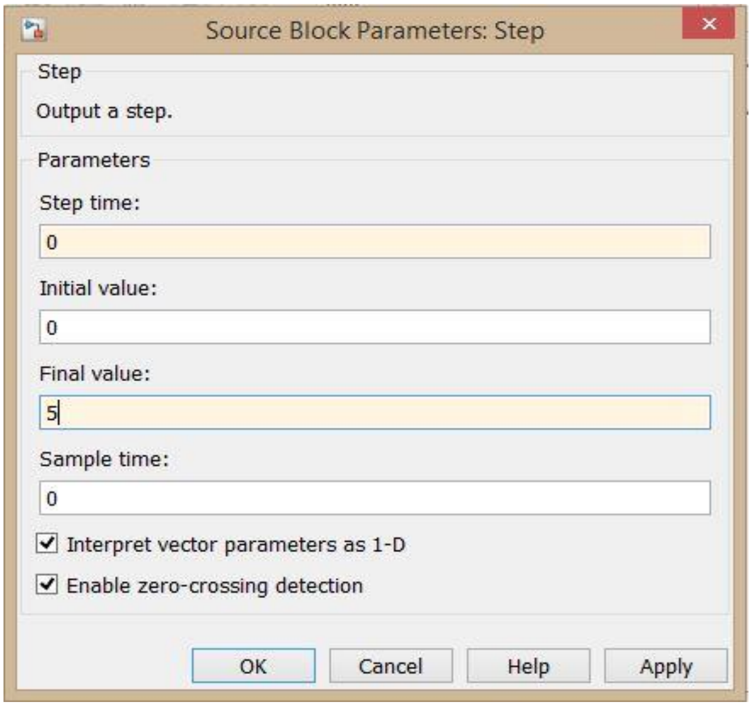
5) Scope (from ‘commonly used block’)

6) Mux (from ‘commonly used block’)

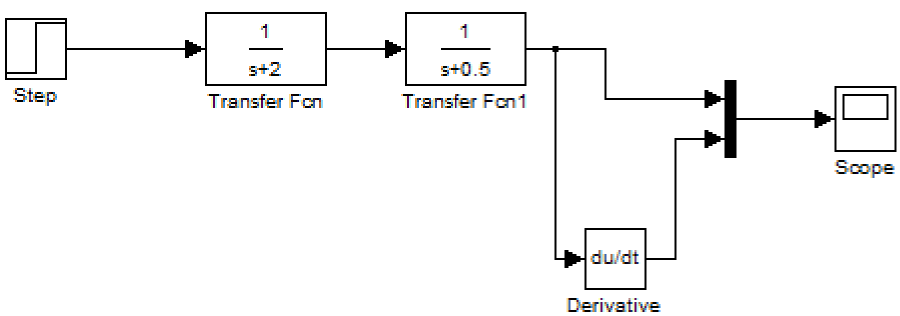
7) Derivative (From ‘continuous’)

Procedure:

1-Double click on the step to change parameter as below:



2- Connect the circuit as below and click run.



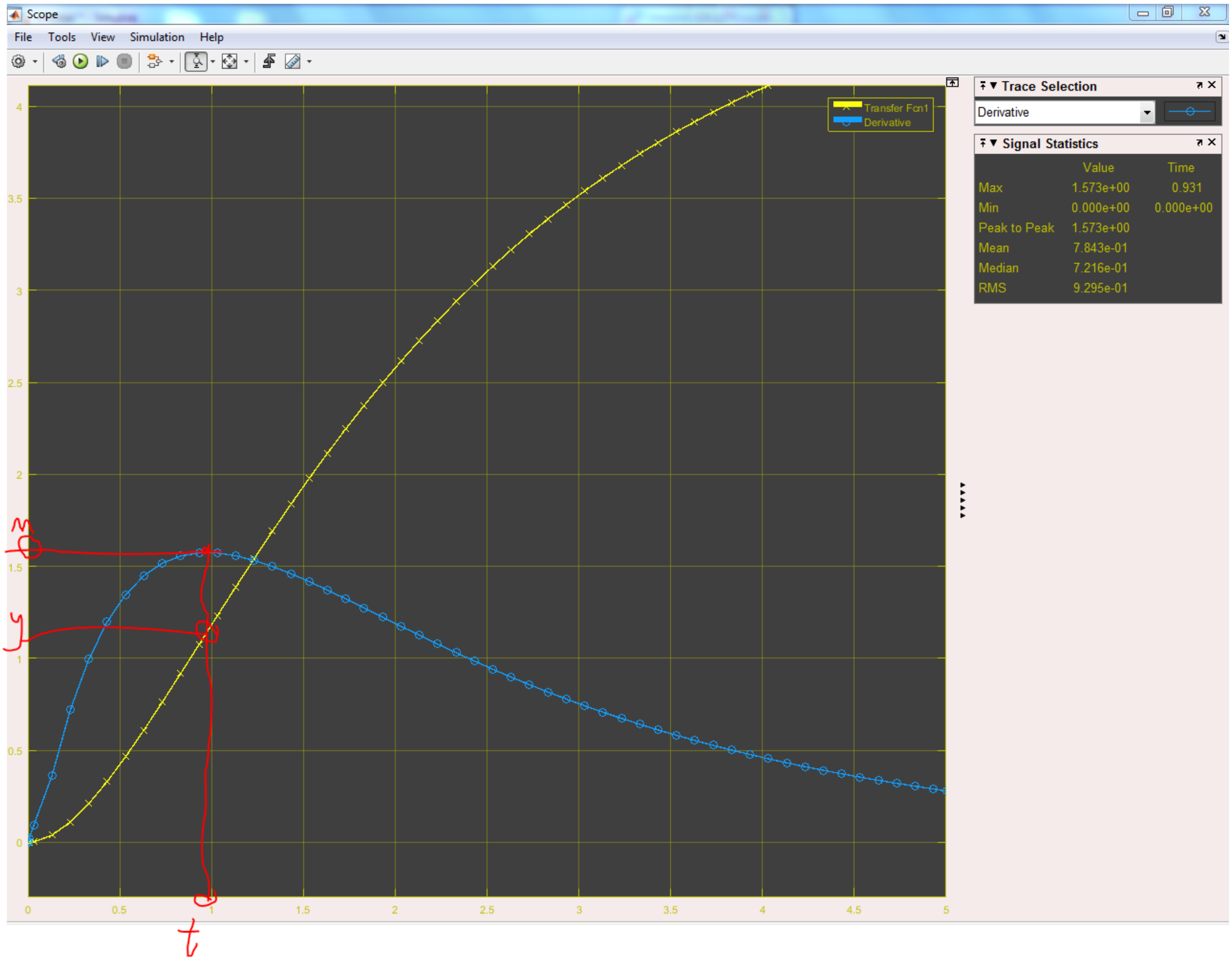


Fig 2: Transfer function and its derivative signal.

4-From the peak of blue curve (derivative of system) find the value of m on the y-axis and t on the x-axis **= m= 1.573**

5-from the value of t in previous find the value of y on yellow curve (open loop system)

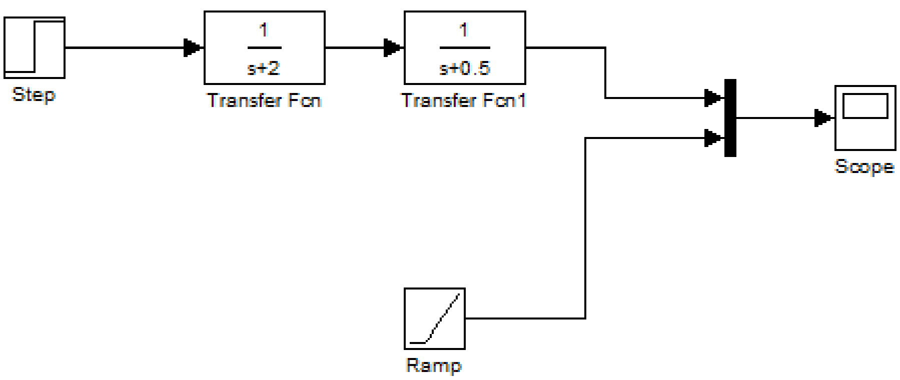
t= 0.931

Y=1.073

6-from the straight line equation y=m*t+α find the value of α=y-m*t

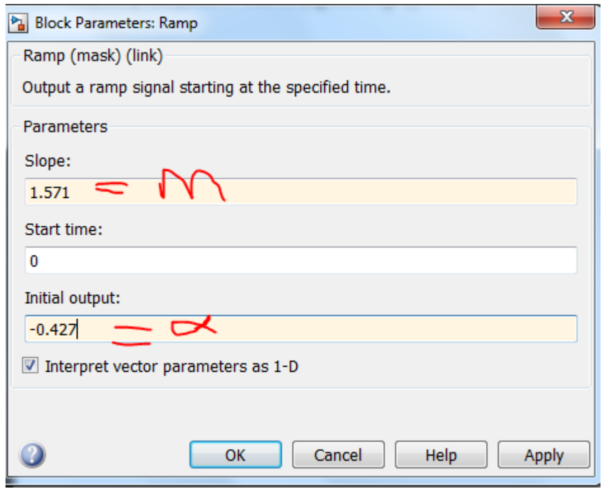
α =1.037-1.573*0.931= -0.427

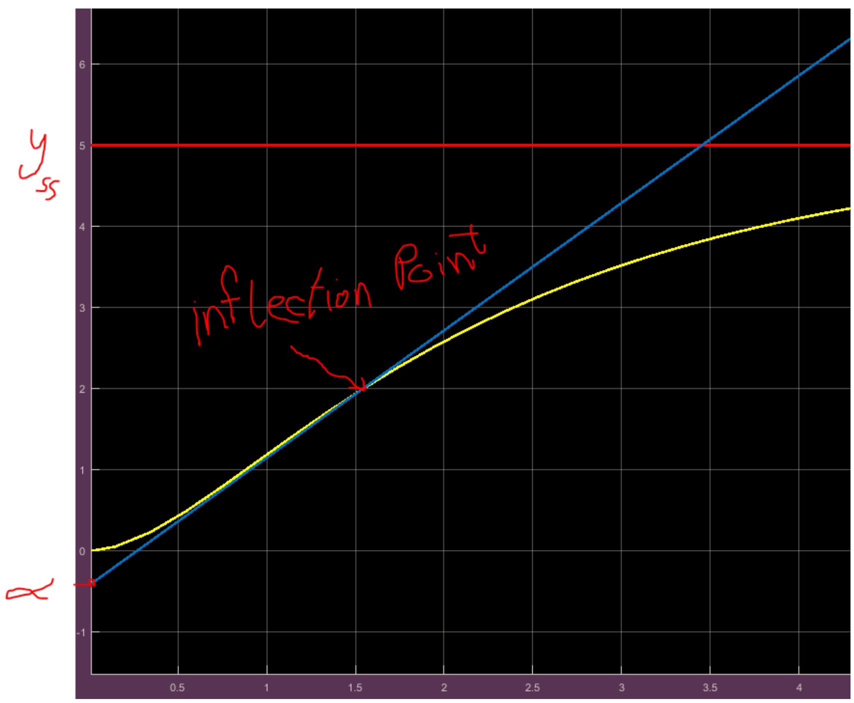
7- connect the circuit as below:



8- Double click on ramp to change the value as slop=m, start time=0, initial output= α and then click run from response find the value of T and L

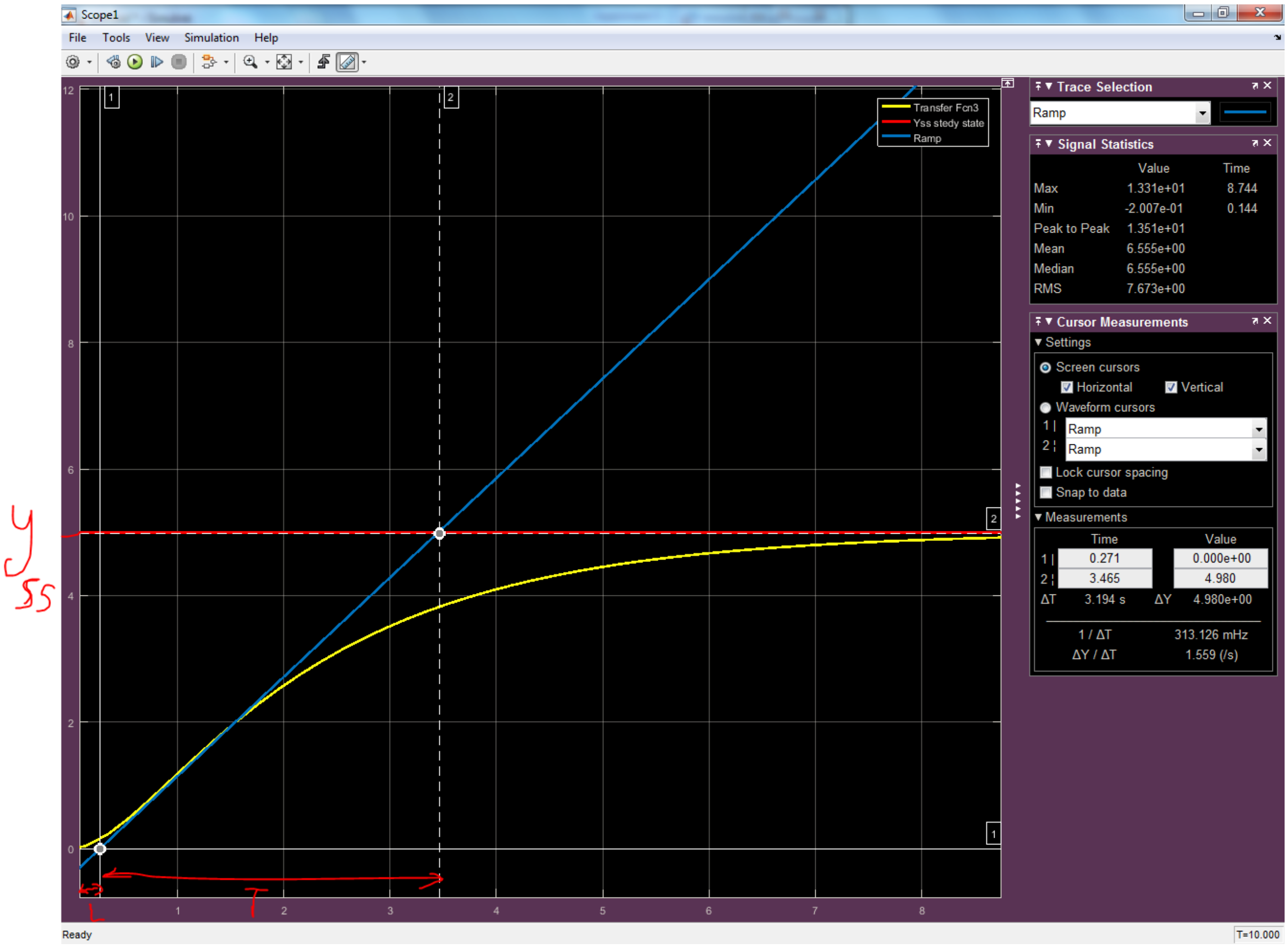
The parameter inside ramp as show in next figure :





The L represents the value from 0 to the intersection of tangent with x- axis

The T represents the value from L to intersection of tangent with final value Yss



From figure L= 0.272 & T= 3.454-0.272=3.182

9- Then compensate the values of T =**0.272** and L=**3.182** in the table below

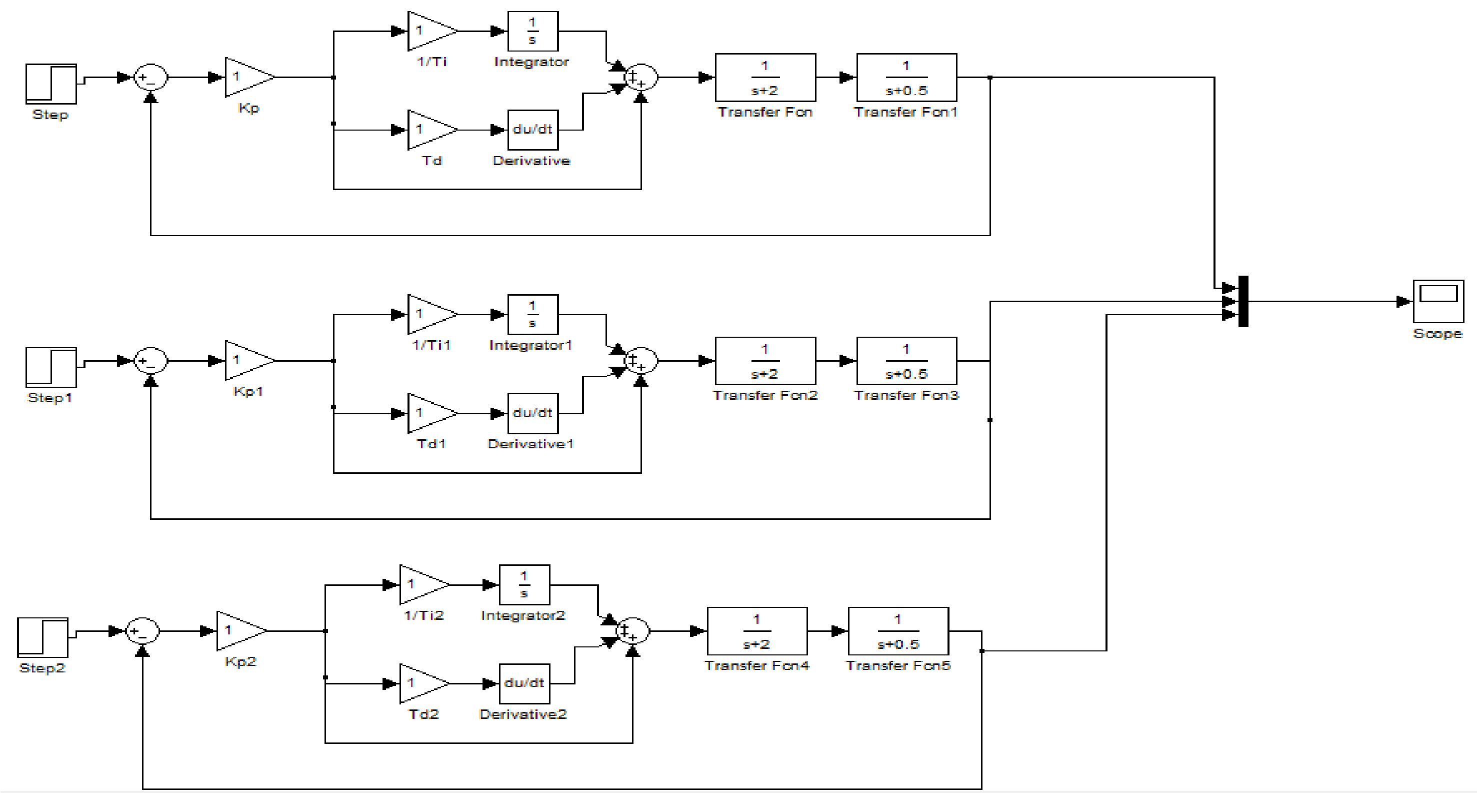
Type of Controller	K_p	T_i	T_d
P	$\frac{T}{L}$	∞	0
PI	$0.9\frac{T}{L}$	$\frac{L}{0.3}$	0
PID	$1.2\frac{T}{L}$	$2L$	$0.5L$

10-connect the circuit as bellow

Compensate the first row value in above table in first graph

Compensate the second row value in above table in second graph

Compensate the third row value in above table in third graph and click run



11- Draw the output response

Question :

1- What is the effect of P, PI, and PID on the system $\frac{1}{(s+2)(s+0.5)}$?

2- What is the advantage and disadvantage for this theory?

3- Is this tuning method complying with the system needs?

4- Which from P, PI, and PID is the best and why?

5-is the first method for this theory applied on the system $\frac{1}{(s+2)(s^2+2s+2)}$ and why?

6- What is the output value from PID controller in Laplace if the value of T=4 and L=2?