Experiment No : 7	Title: Tuning by Ziegler and Nichols second method

Objective:

To get an automatic tuning for the system $\frac{1}{(s+1)(s^2+2s+2)}$ since manual tuning is hard to adjust and not available always and the first method condition does not match.

Theory:

The conditions of second method for Ziegler and Nichols theory

Add gain (Kp) to the system with unity feedback then find the total transfer function and from

The characteristic equation apply the Routh–Hurwitz stability criterion if there is appositive

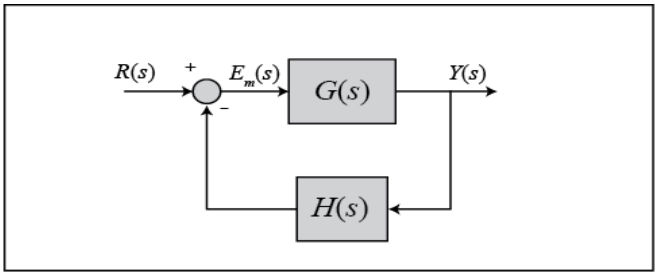
value for gain value (Kp) make any value in first coulomb zero then the system make

identical oscillation and the Theory is applied and this value of Kp represent Kcr

For example G(s) = $\frac{(s+2)(s+3)}{s(s+1)(s+5)}$

The first method does not applied let check for second method conditions

First add gain to the system with unity feed back



T.F= $\frac{G(s)}{1+G(s)*H(s)} = \frac{\frac{kp*(s+2)(s+3)}{s(s+1)(s+5)}}{1+\frac{kp*(s+2)(s+3)}{s(s+1)(s+5)}} = \frac{kp(s+2)(s+3)}{s(s+1)(s+5)+kp(s+2)(s+3)}$

The characteristic equation is s(s+1)(s+5)+kp(s+2)(s+3) =s^3+(6+kp)s^2+(5+5kp)s+6kp=0

The routh array become

s^3	1	5+5kp
s^2	6+kp	6kp
s^1	$\frac{30+35kp+5kp^2}{6+kp}$	
s^0	6kp	

There is no appositive value of Kp to make any value in first coulomb zero so the theory is not applied

Another example

G(s) = $\frac{1}{(s+1)(s^2+2s+2)}$

The first method does not applied let check for second method conditions

First add gain to the system with unity feed back

T.F= $\frac{G(s)}{1+G(s)*H(s)} = \frac{\frac{kp}{(s+1)(s^2+2s+2)}}{1+\frac{kp}{(s+1)(s^2+2s+2)}} = \frac{kp}{(s+1)(s^2+2s+2)+kp}$

The characteristic equation is (s+1)(s^2+2s+2)+kp= s^3+3s^2+4s+2+kp=0

The routh array become

s^3 1 4

s^2 3 2+kp

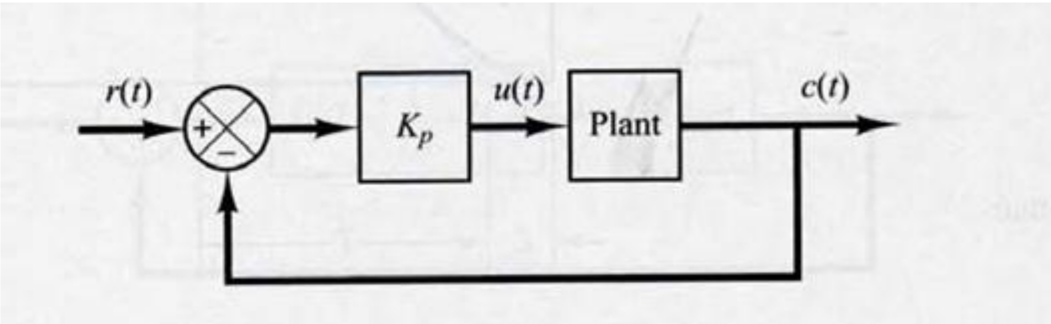
s^1 $\frac{12-2-kp}{3}$

s^0 2+kp

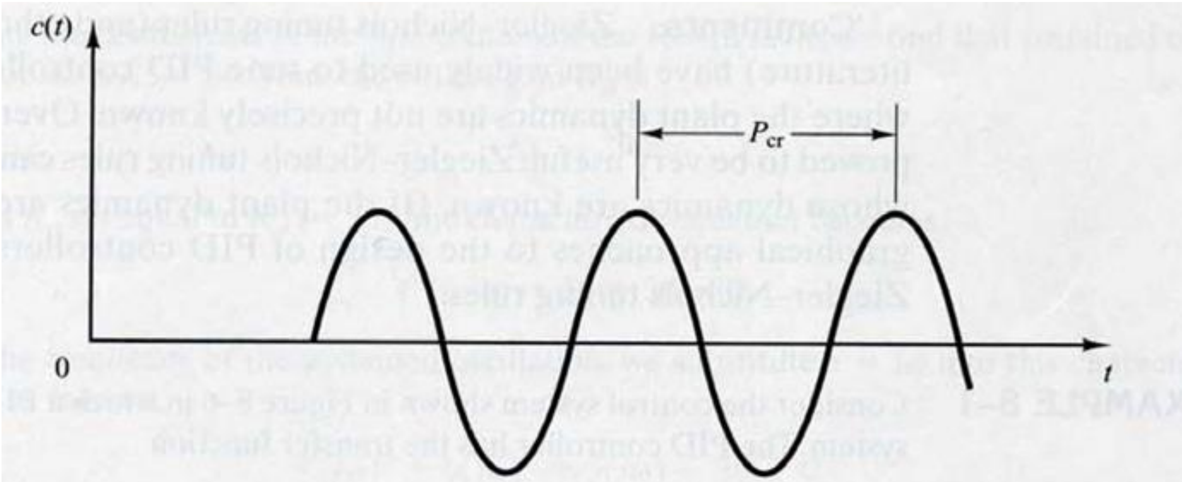
There is appositive value of Kp=10 to make any value in first coulomb zero so the theory is applied for this system

Second method theory:

Add again kp to the system with unity feedback as shown below:



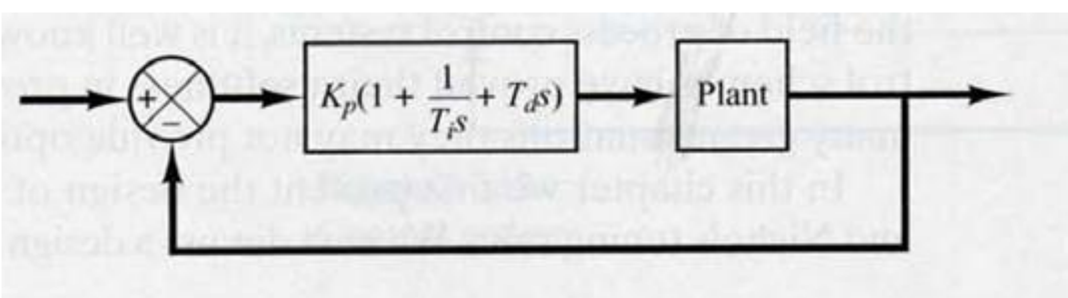
Then increase the value of gain Kp to get identical oscillation in the output this value of gain that get identical oscillation called Kcr and the distance between any two peak called Pcr as shown below:



Then compensate the values of Kcr and Pcr in the table below:

Type of Controller	K_p	T_i	T_d
P	$0.5K_{cr}$	∞	0
PI	$0.45K_{cr}$	$\frac{1}{1.2}P_{cr}$	0
PID	$0.6K_{cr}$	$0.5P_{cr}$	$0.125P_{cr}$

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’)

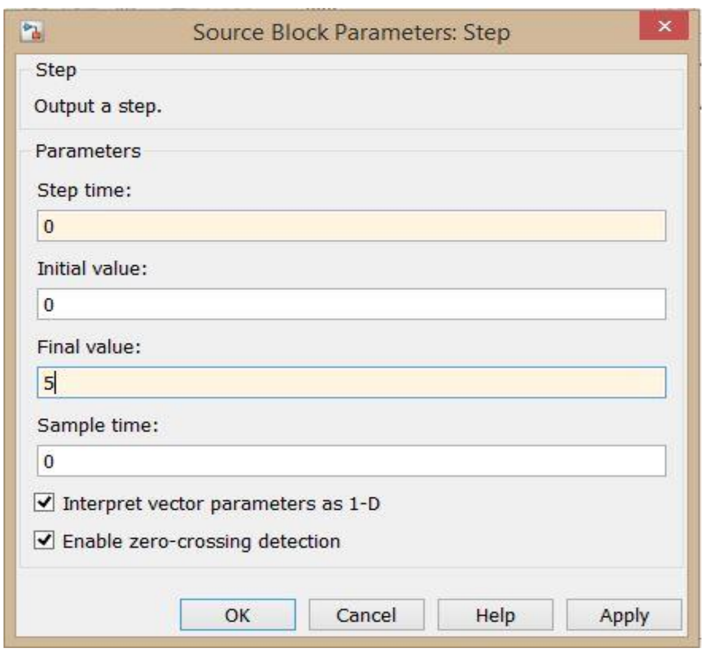
5) Scope (from ‘commonly used block’)

6) Mux (from ‘commonly used block’)

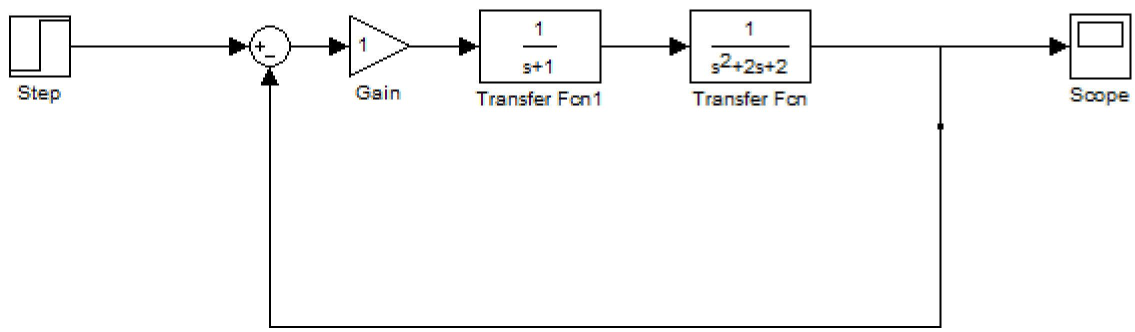
7) Derivative (From ‘continuous’)

Procedure:

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



2- Connect the circuit as below:

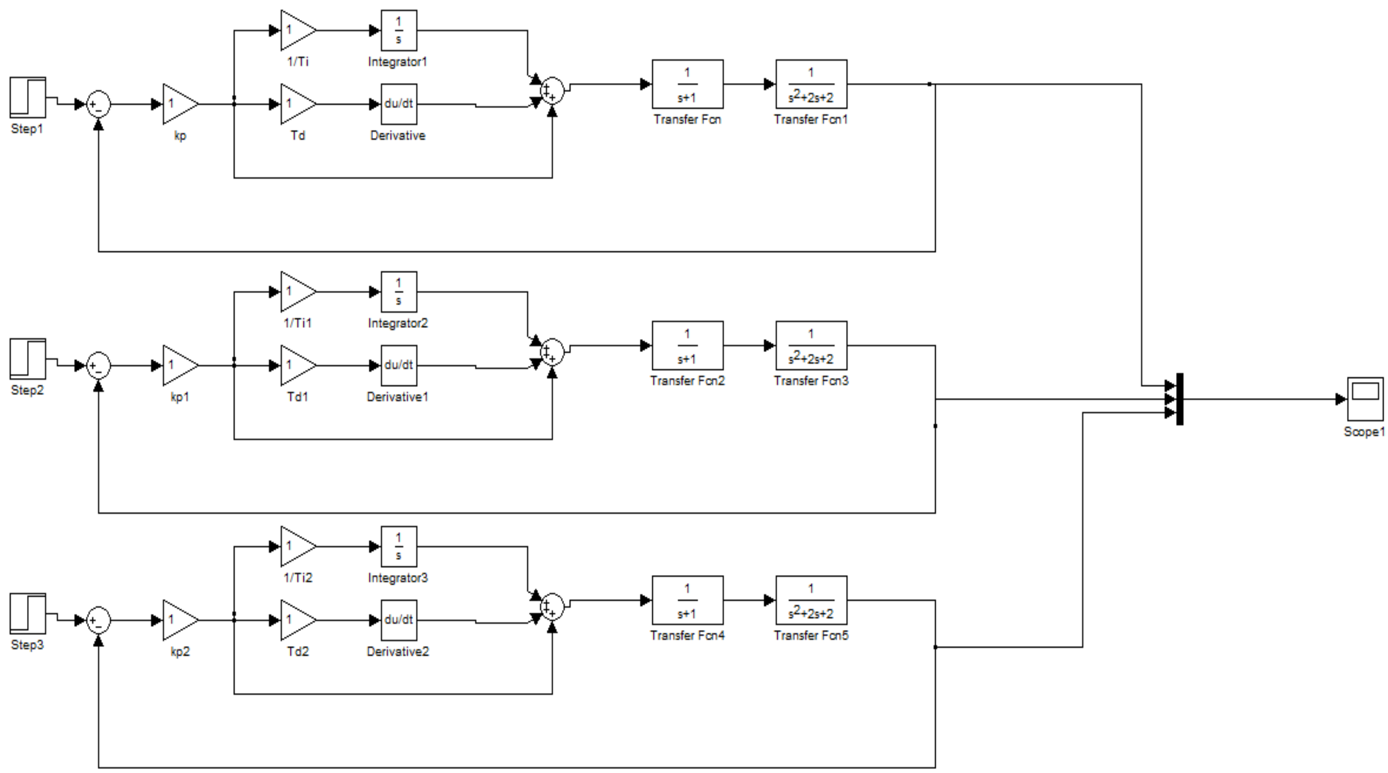


3- Change the value of gain to get identical oscillation in the output this gain called Kcr and distance between any two peaks called Pcr

4-Then compensate the values of Kcr and Pcr in the table below:

Type of Controller	K_p	T_i	T_d
P	$0.5K_{cr}$	∞	0
PI	$0.45K_{cr}$	$\frac{1}{1.2}P_{cr}$	0
PID	$0.6K_{cr}$	$0.5P_{cr}$	$0.125P_{cr}$

5-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

6-Draw the output response

Question :

1- What is the effect of P, PI, and PID on the system $\frac{1}{(s+1)(s^2+3s+3)}$?

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- What is the output value from PID controller in Laplace if the value of kcr=12 and pcr=5?

6-is the theory applied on the system $\frac{1}{(s+0.5)(s^2+2s+2)}$check for that if yes what is the value for Kcr?