PID LAB

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جروب :- 2

Question 1: Effect of PID parameters, PID tuning Simulate the second order capacitor as in experiment and use R1 = R2 = 50k ohm, C1 = 100 micro F, C2 = 200 micro F. then run the MATLAB code to start display the response of the system for 60 second.

Required

1 - Measure and record the rise time, error steady state and overshoot in each case.

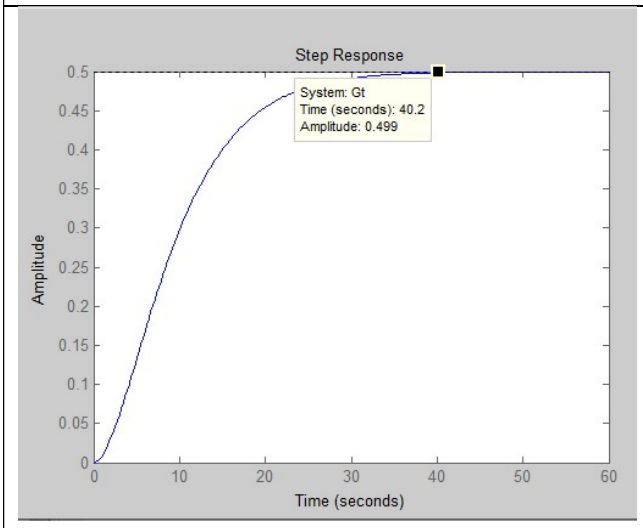
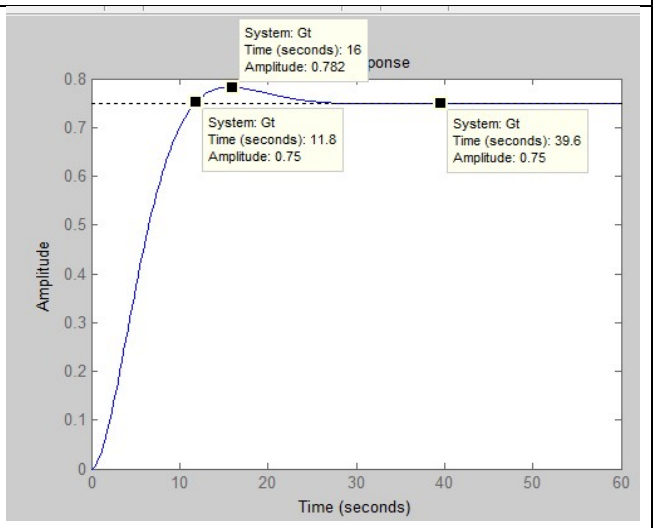
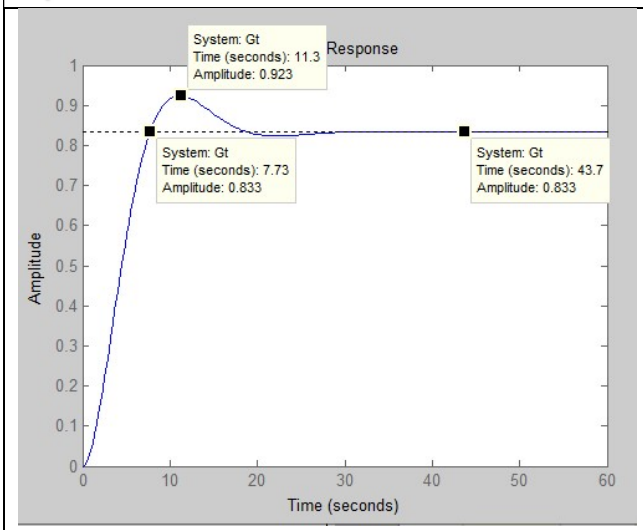
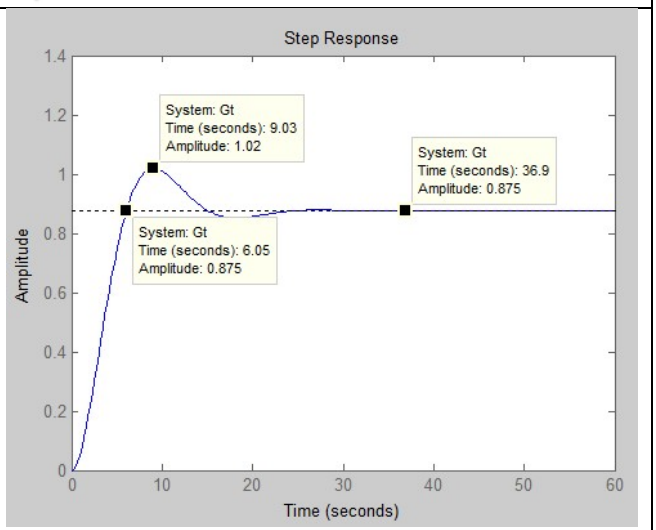
- **case 1 : P controller (ki=0,kd =0) change kp (kp =1,3,5,7,9)**

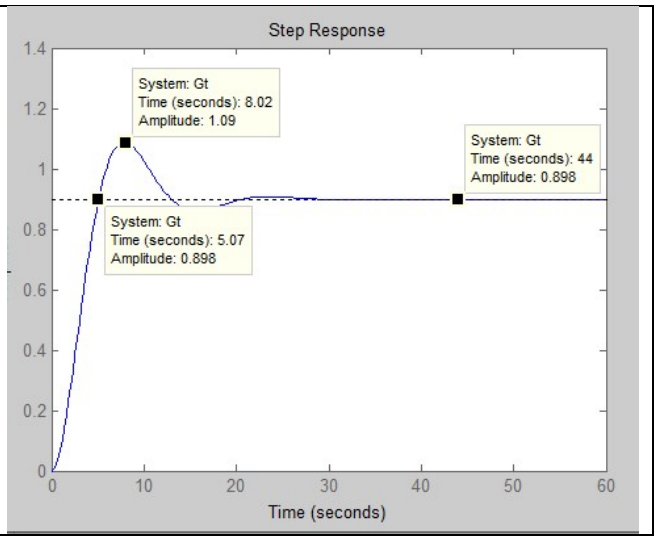
	Openloop	kp=1	kp= 3	kp =5	kp=7	kp= 9
Rise time	95.6	46.2	11.8	7.73	6.05	5.07
offset	0.004	0.5	0.25	0.167	0.125	0.102
overshoot	0	0	0.032	0.091	0.145	0.192

Comment in case 1:-

Using only Proportional gain will fast the response. By increasing the gain faster response (rise time decrease) the system has a steady-state error (Offset) that decrease by increasing the gain. the system can be unstable by increasing gain overshoot increasing.

Output of matlab case 1:-

Kp =1	Kp = 3
	
Kp = 5	**Kp = 7**
	

Kp = 9	

❖ case 2-PI controller (kp = 3) , change ki(0 , 0.1, 0.3, 0.5,0.7,1, 1.5,2)

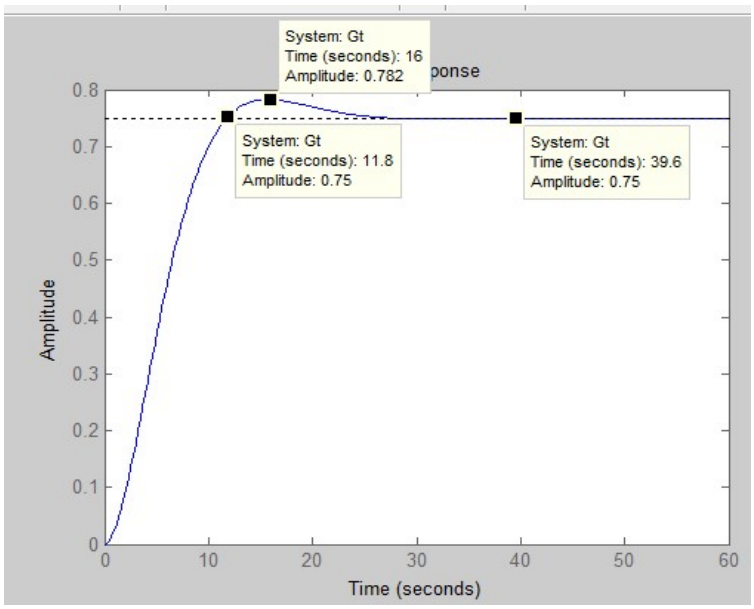
	Ki =0	Ki=0.1	Ki=0.3	Ki=0.5	Ki=0.7	Ki=1	Ki=1.5	Ki=2
Rise time	11.8	162	10.5	8.77	7.88	7.03	6.17	Infinity unstable
offset	0.25	0	0	0	0	0	0	
overshoot	0.032	0	0.19	0.36	0.5	0.66	0.83	

Comment in case 1:-

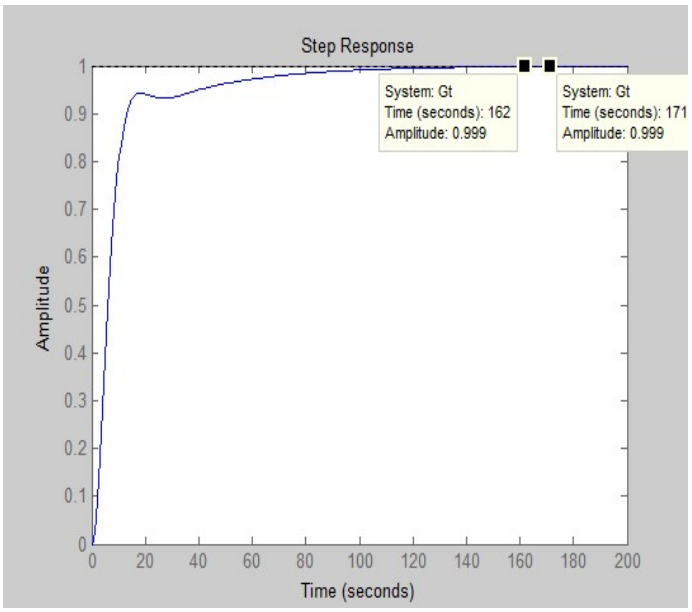
Adding Integral to const Proportional value will remove steady-state error (offset). Increasing integral will increase the overshoot and reduces system stability until gain =2 system be unstable.

Output of matlab case 2:-

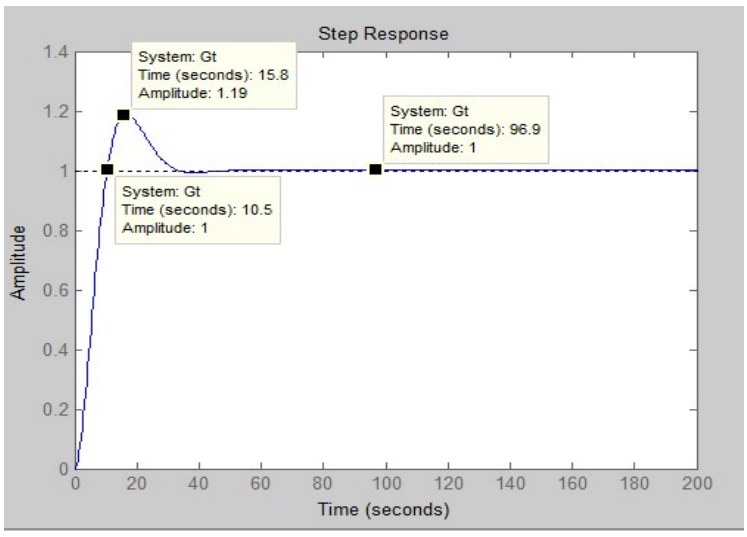
Ki=0



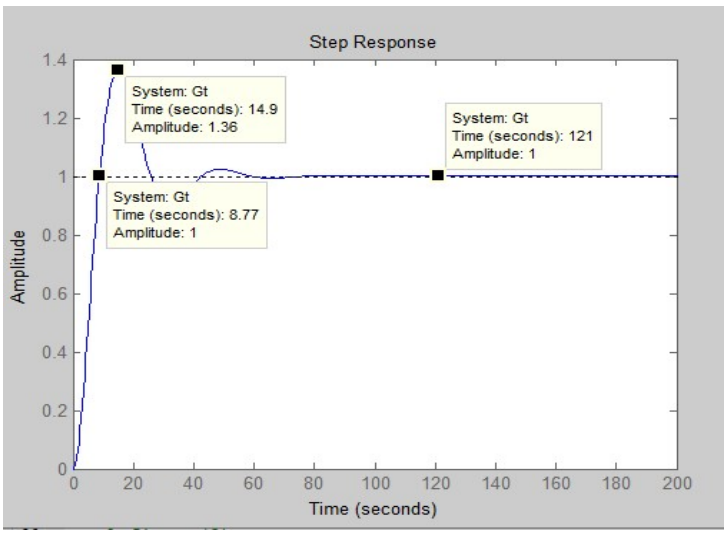
Ki=0.1



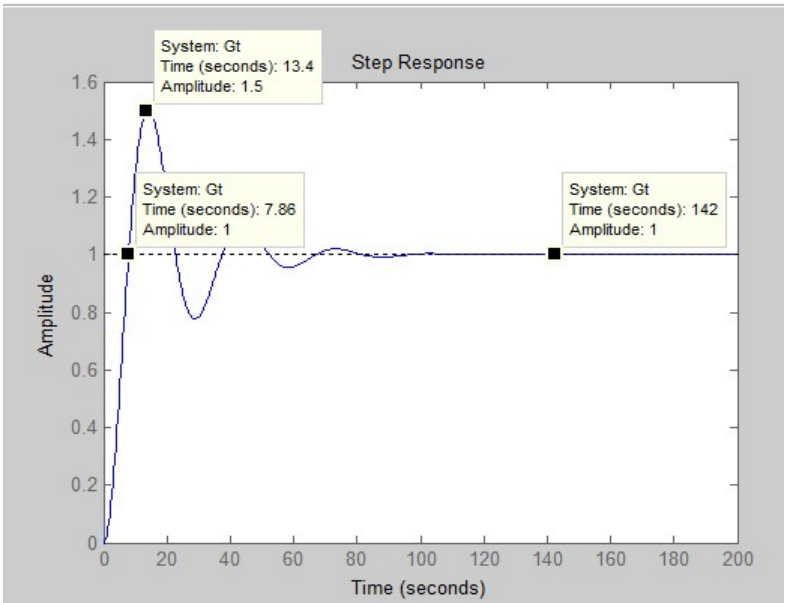
Ki =0.3



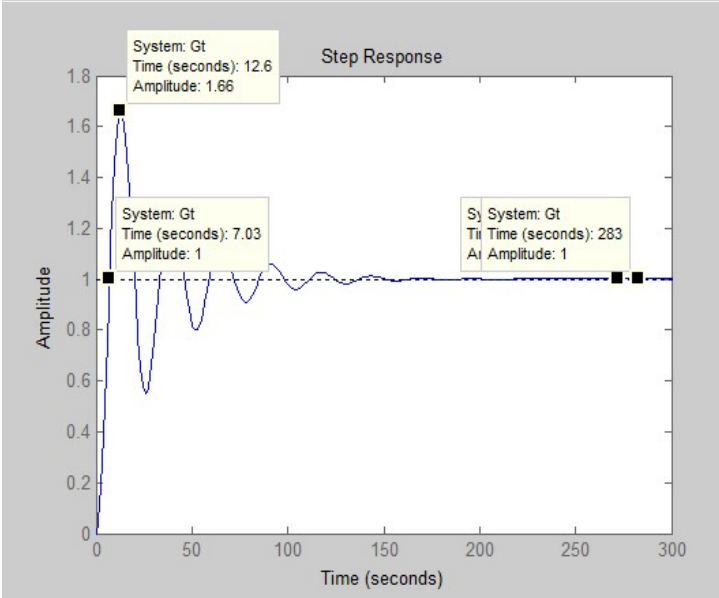
Ki =0.5



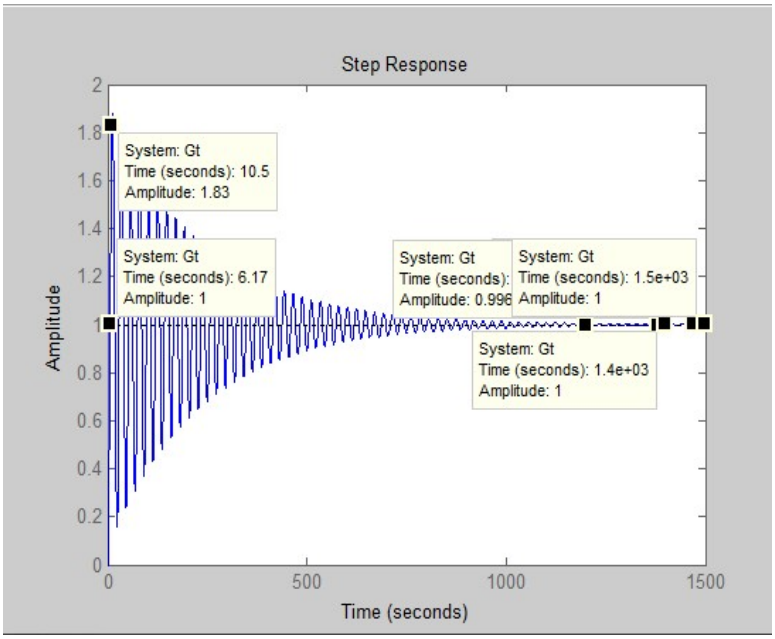
Ki =0.7



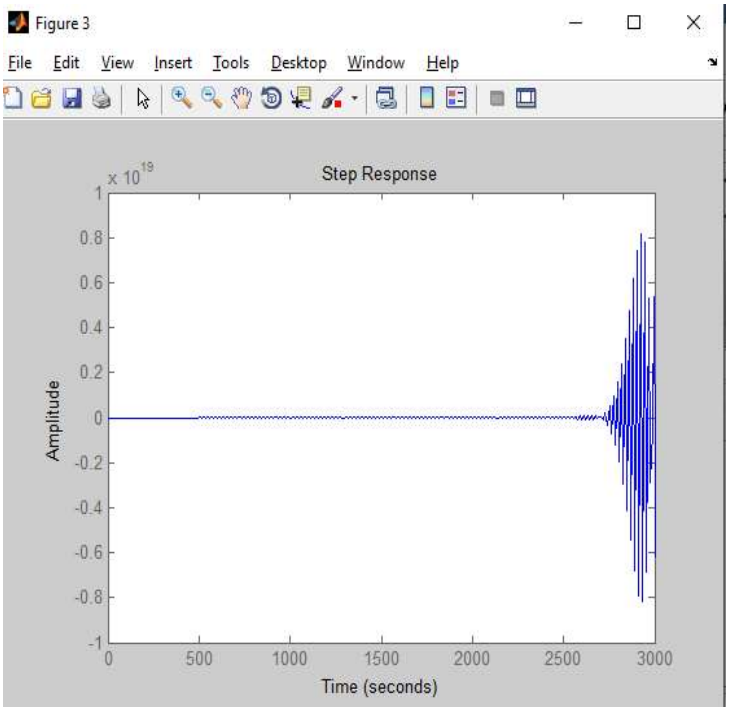
Ki =1



Ki =1.5



Ki =2



❖ case 3- PID controller(kp = 3, ki = 0.5),change kd (0 , 0.5 , 1 , 1.5 , 2 ,2.5 , 3 , 4)

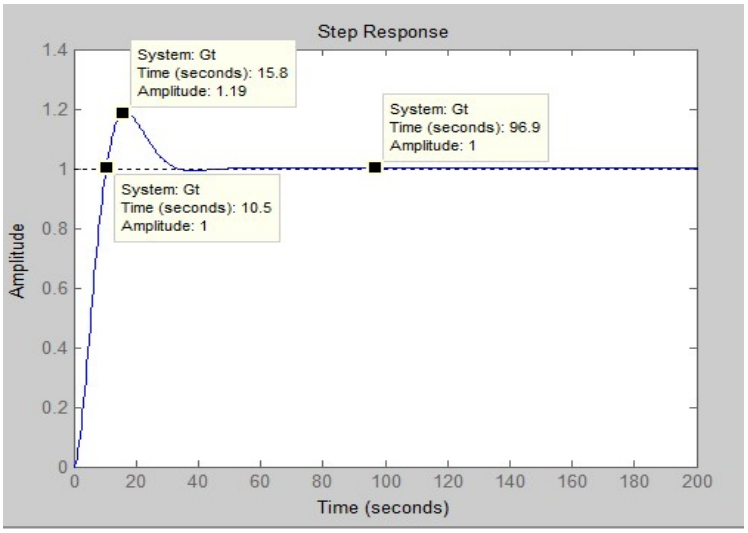
	Kd=0	Kd=0.5	Kd=1	Kd=1.5	Kd=2	Kd=2.5	Kd=3	Kd=4
Rise time	8.77	8.85	8.93	8.99	9.07	9.17	9.25	9.43
offset	0	0	0	0	0	0	0	0
overshoot	.36	0.35	0.34	0.32	0.31	0.3	0.29	0.27

Comment in case 3:-

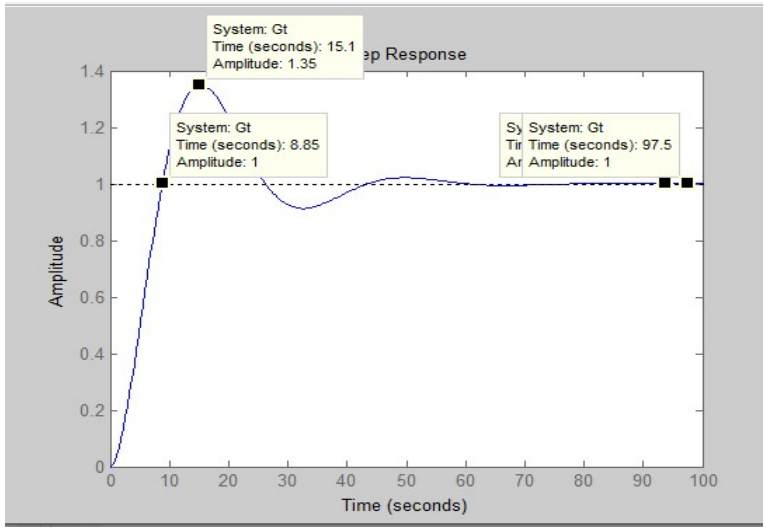
Adding Derivative to const Integral and Proportional values Derivative will improve the transient response and reduce overshoot.

Output of matlab case 3:-

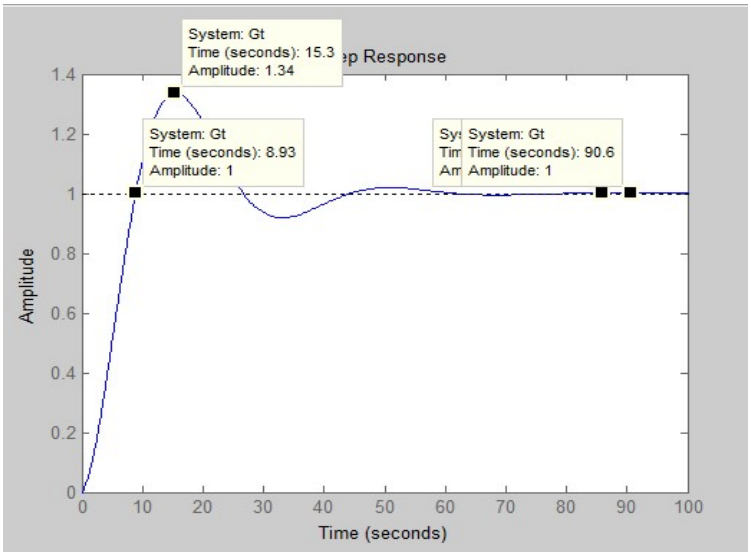
Kd=0



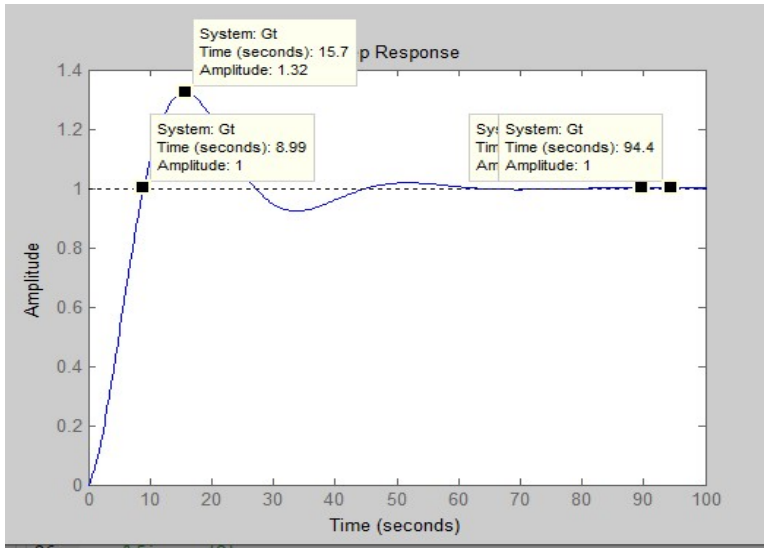
Kd=0.5



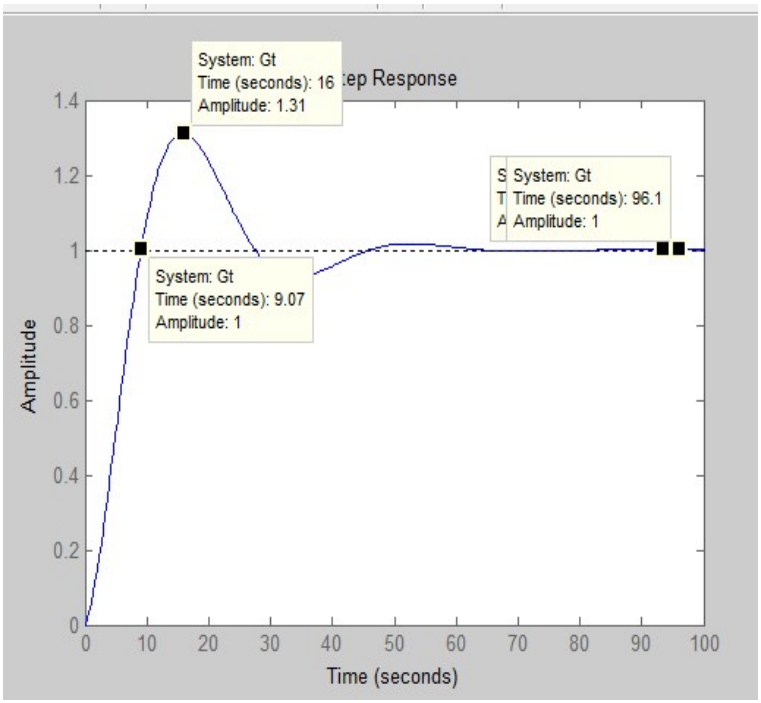
Kd=1



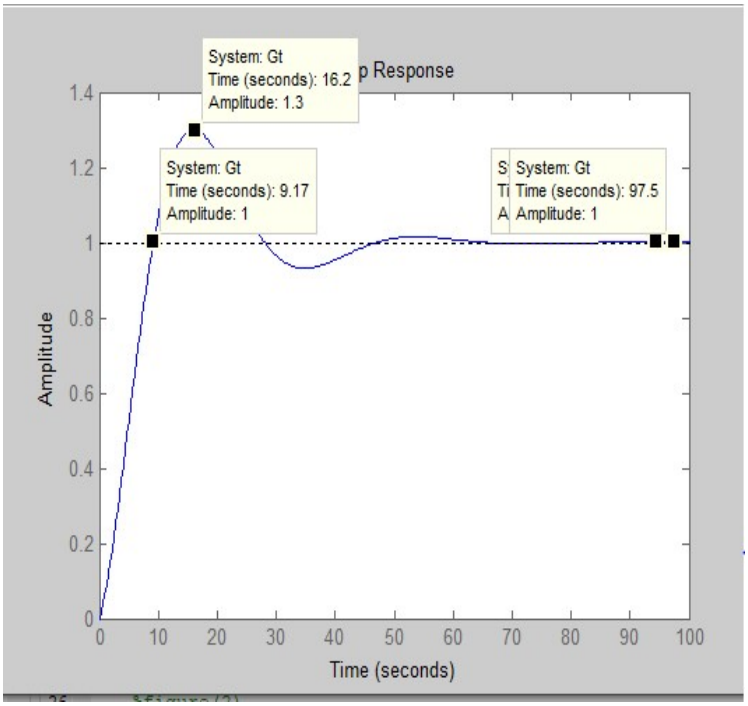
Kd=1.5



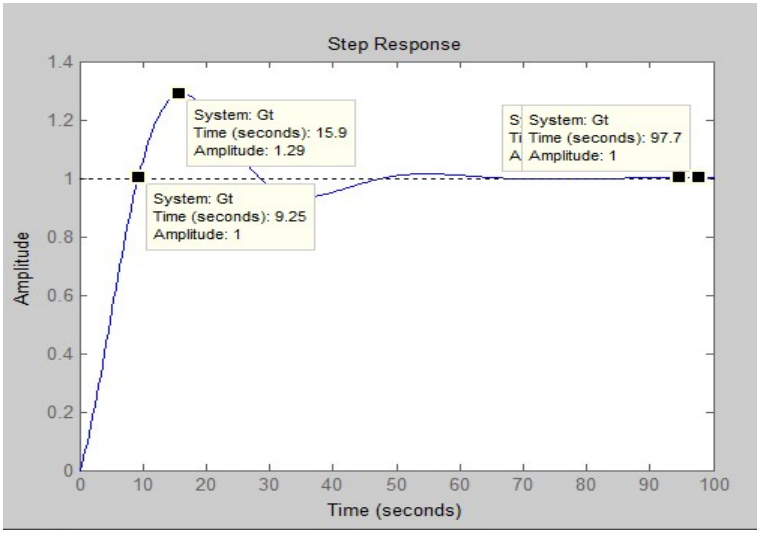
Kd=2



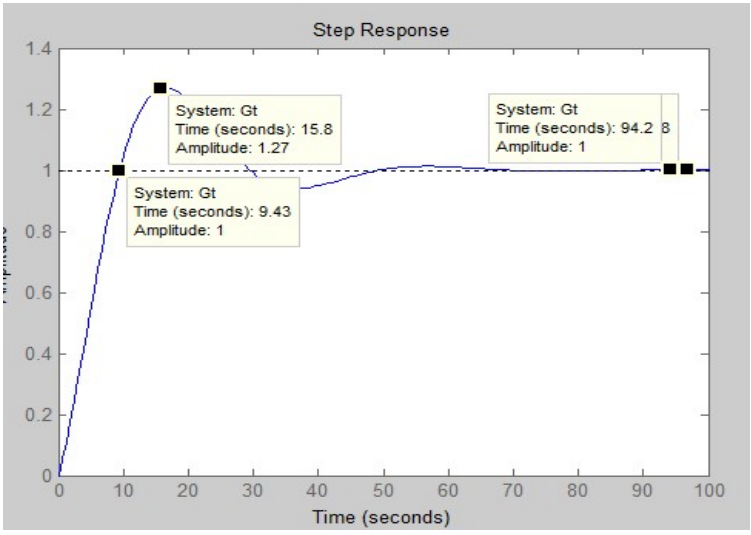
Kd=2.5



Kd=3

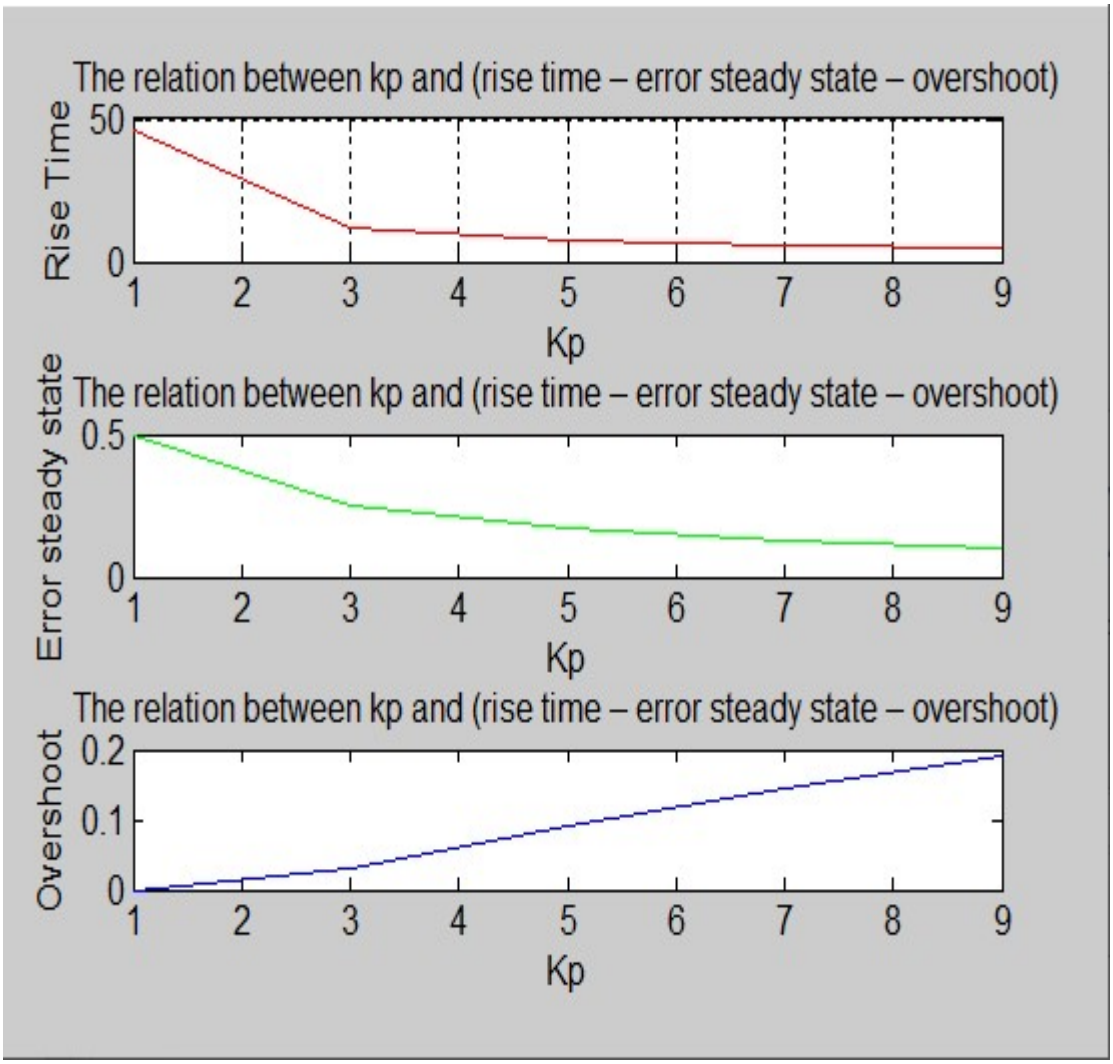


Kd=4

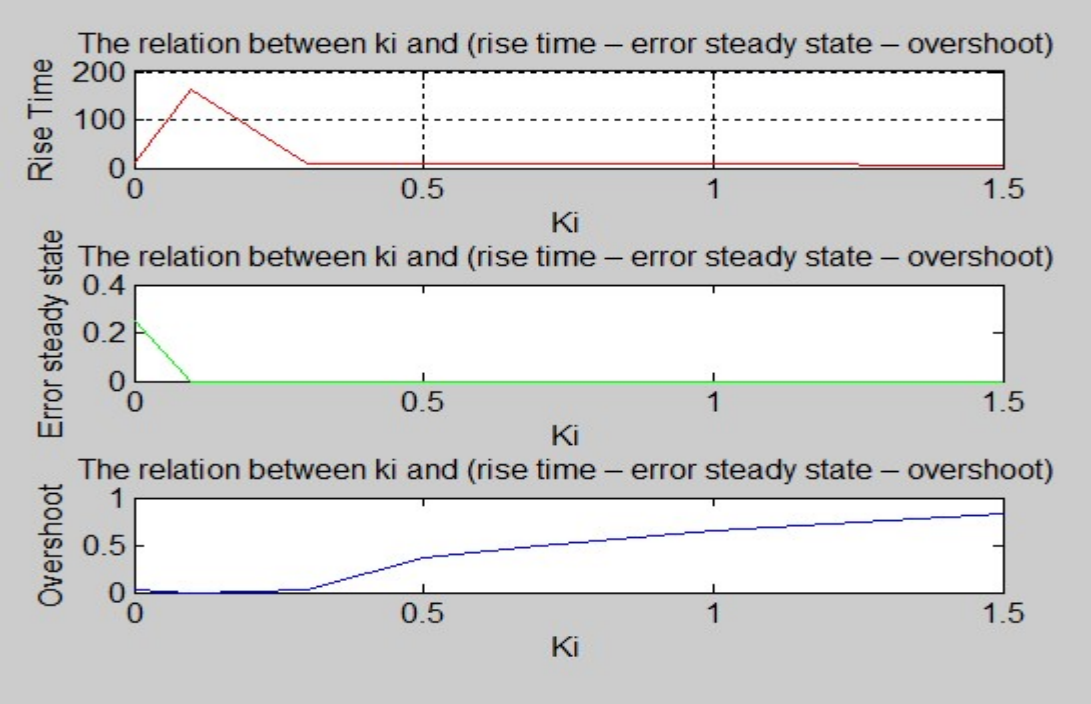


2- Draw the relation between kp, ki ,kd and (rise time – error steady state –overshoot)

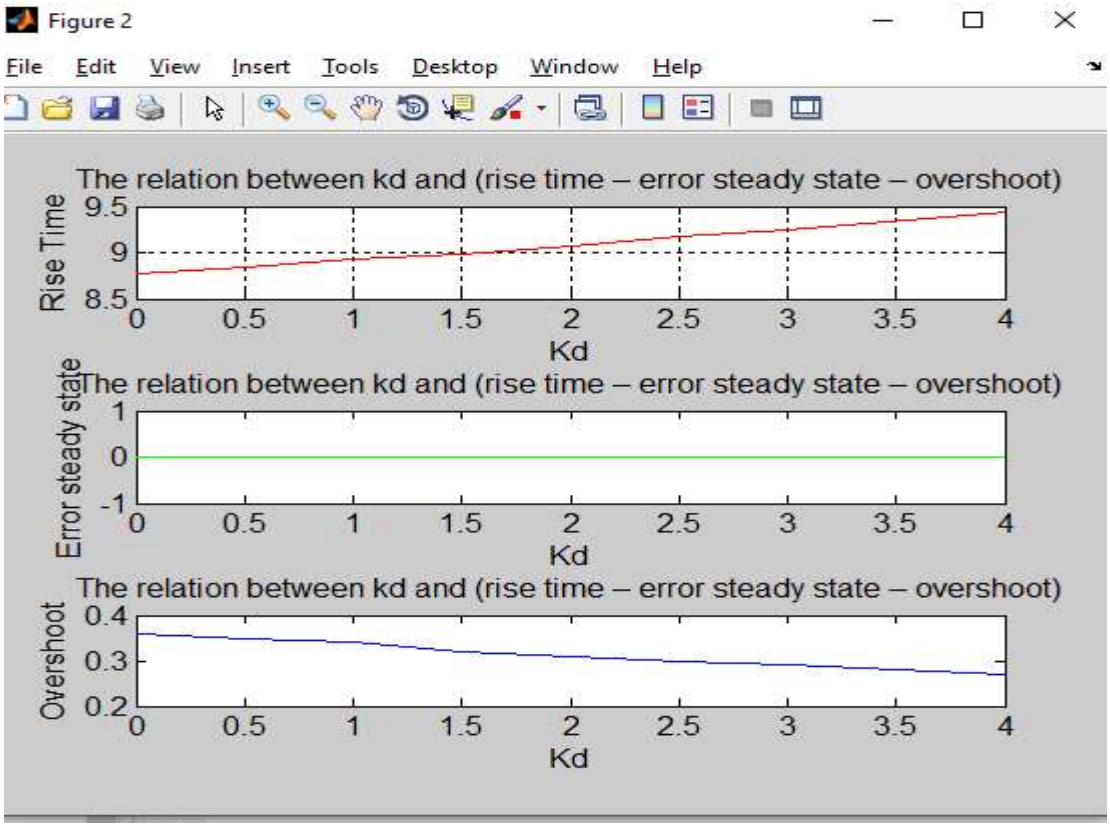
- **relation between kp and (rise time – error steady state –overshoot)**



- **relation between ki and (rise time – error steady state –overshoot)**



- **relation between kd and (rise time – error steady state –overshoot)**

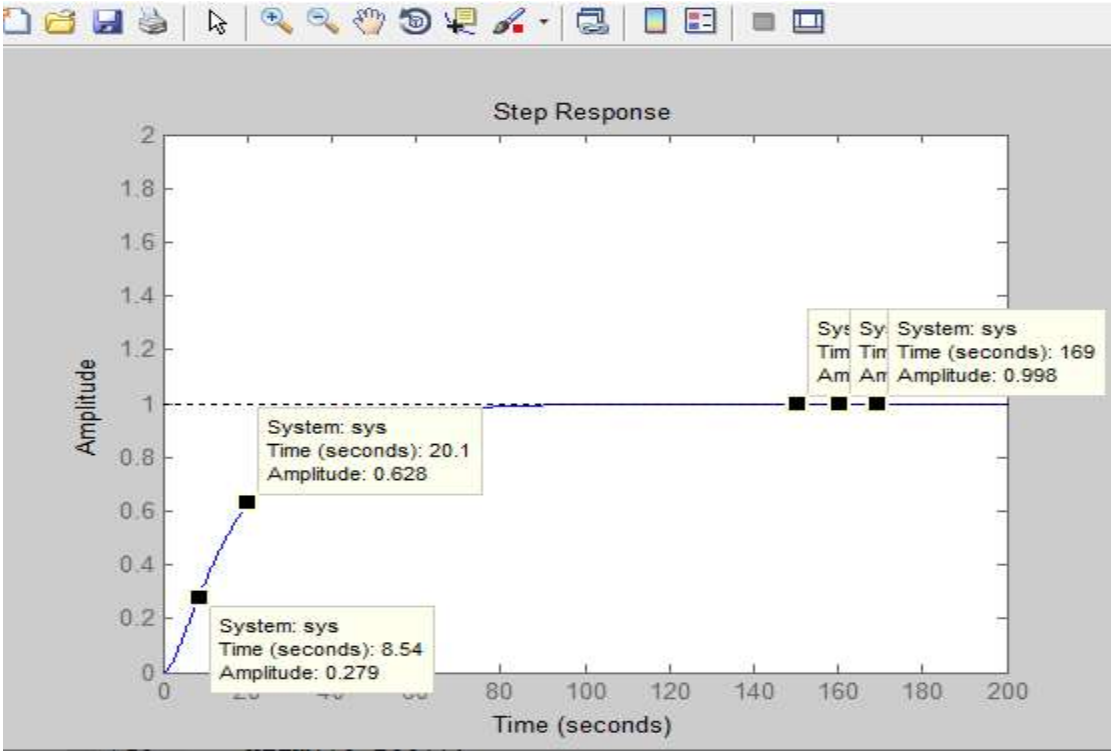


3- Summarize your result in this table Write word to describe the relation (e.g., increase – decrease - not effect,etc)

	Rise time	Offset(steady state error)	overshoot
kp	Decrease	Decrease	increase
ki	Decrease	Decrease	increase
kd	Small change	No change	Decrease

4- Apply PID tuning using Ziegler-Nichols rule and draw the response in your report.

1- From open loop: -



- **Input is step so small delta will=1 and delta =.998 from open loop figure so k =.998 .**
- **Ταυ (τ) =1.5 *(t(63%) - t(28%)) → (τ) = 1.5 * (t(0.628) -t(0.279)) (τ) = 1.5 *(20.1 -8.54) =17.34**
- **Time delay (td) = t(63%) - (τ)→ td = 20.1-17.34 = 2.76**
- **Ziegler-Nichols open-loop tuning equations for the appropriate controller PID to calculate the controller constants.**

Kp = 7.539

Ki = 1.365

Kd = 5.463