NED University of Engineering & Tech.

Electrical Engineering Department

Spring Semester 2020

TE-ME / TE-EE / TE-EL

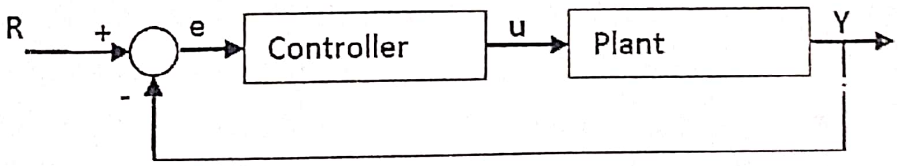
Lab Session 10

Exercise:

Question 1:

For the feedback system shown below, complete the following observation table,

PID values (K_p, K_I, K_d)		Closed loop System Response				
		Rise time	Settling time	Peak time	Overshoot	Steady state error
Increasing K_p	(100, 1, 1)	0.7714	75.3800	2.1652	0.7123	2.7×10^{-3}
	(150, 1, 1)	0.6215	54.1163	1.7815	0.7684	4.6×10^{-3}
	(250, 1, 1)	0.4752	41.9979	1.3889	0.8242	6.0×10^{-3}
	(500, 1, 1)	0.3317	37.6293	0.9871	0.8791	5.4×10^{-3}
Increasing K_i	(500, 10, 1)	0.3310	39.7534	0.9873	0.8877	2.51×10^{-5}
	(500, 20, 1)	0.3302	43.6372	0.9874	0.8972	6.37×10^{-8}
	(500, 50, 1)	0.3277	64.3584	0.9875	0.9255	9.59×10^{-9}
	(500, 100, 1)	0.3238	299.7915	0.9871	0.9714	9.8×10^{-3}
Increasing K_d	(500, 10, 10)	0.3374	21.9334	0.9707	0.8127	2.50×10^{-5}
	(500, 10, 20)	0.3425	14.1109	0.9530	0.7392	2.50×10^{-5}
	(500, 10, 50)	0.3473	6.3406	0.9045	0.5664	2.49×10^{-5}
	(500, 10, 100)	0.3343	4.1529	0.8356	0.3824	2.47×10^{-5}



$$\text{Plant} = \frac{\frac{1}{50}}{s^2 + \frac{10s}{50} + \frac{5}{50}}$$

$$\text{Controller} = K_p + \frac{K_I}{s} + K_d s$$

Use MATLAB script present in Lab session 10 of the manual to find the step response of the closed loop transfer function for the above mentioned plant and PID values. Use MATLAB script present in Lab session 07 of the lab manual to find the time specification of all the step responses of closed loop transfer function with above mentioned plant and PID values. Use time vector as `[0:0.0001:300]` for plotting step responses.

Write the complete MATLAB script on the separate A4 sheet and attach it with this document. Complete the table present in this document and conclude the table.

Only write conclusion below this line. Use blank A4 sheets to write MATLAB script and attach it with this document.

CONCLUSION:

For Kp:-
If the value of Kp increases so rise time, settling time and peak time will also increase while Overshoot will be decreased for given closed loop system.

For Ki :-
If the value of Ki increases so settling time and overshoot also increase and decreasing in rise time & steady state error while no change in peak time.

For Kd:-
If the value of Kd increases so settling time, peak time and overshoot will be decreased and small change in rise time, no change in steady state error will be acheived for given system.

PROGRAM SCRIPT:-

```
clear, clc, close
num = 1/50;
den = [1 10/50 5/50];
plant = tf(num, den)
step (plant); grid on;

Kp = 100; Ki = 1; Kd = 1;     % By changing these values get
                                different result
contr = tf[Kd Kp Ki], [1 0]);
sys_cl = feedback (contr* plant, 1)
t = 0 : 0.0001 : 300;

figure
[n,d] = tfdata(sys_cl);
step (n,d,t); grid on;
[y,x,t] = step (n,d,t);

% to find rise time i.e time taken for output to rise
% from 10% to 90%
k = 1;
while y(k) <= 0.1;
        k = k+1;
end
tenpercent = t(k);
while y(k) <= 0.9;
        k = k+1;
end
nintypercent = t(k);
```

```
rtime = nintypercent - tenpercent;
fprintf('The rise time is: %f sec \n', rtime);
format short
k = 1;
% to find maximum overshoot
for k= 1: length(t)-1
    if y(k+1) <= y(k);
        % to find value of k till response keeps rising
        break;
    end
end
Oshoot = y(k)-1;
fprintf('The overshoot is: %f sec\n', Oshoot);
% to find the peak time
tp = t(k);
fprintf('the peak time is : %f sec \n', tp)
% to find the settling time and state taken as 2%.
tol = 0.02;
for k=length(t)-1 :-1 :2;
    if (abs (y(k)-y(length(t)-1)) > tol)
        break;
    end
end
stime = t(k);
fprintf('the settling time is : %f sec\n', stime)
sserror = abs(1-y(end));  % find steady state error
fprintf('the steady state error is : %f sec', sserror)
```