Ex. No. **1**	**DERIVE THE CONTROLLER GAIN USING ROOT LOCUS FROM THE TIME DOMAIN SPECIFICATION**
10-01-2020	

Aim:

To Derive the Controller gain using root locus from the time domain specification.

Tools required:

1. Matlab
2. Personal Computer

Formula Used:

i) % Peak Overshoot :

$$\% \text{ pk} = e^{-\frac{\delta\pi}{\sqrt{(1-\delta^2)}}}$$

where δ = Damping Ratio

ii) Rise Time:

$$T_r = \frac{\pi-\theta}{\omega_d} \qquad \text{where} \quad \theta = \frac{\tan^{-1}(\sqrt{1}-\delta^2)}{\delta}$$

where $\omega_d = \omega_n\sqrt{1-\delta^2}$

ω_d = Damping Frequency

ω_n = Natural Frequency

The physical parameter are :

% Peak Overshoot = 5%

Rise Time = 3 sec

Procedure:

1. Matlab Software:

- The Matlab Software is operated and a new Script Screen is opened.
- The Damping ratio and Natural frequency are found using the data sheet and data(% of Peak Overshoot, Rise time).

2. Experiment's Procedure:

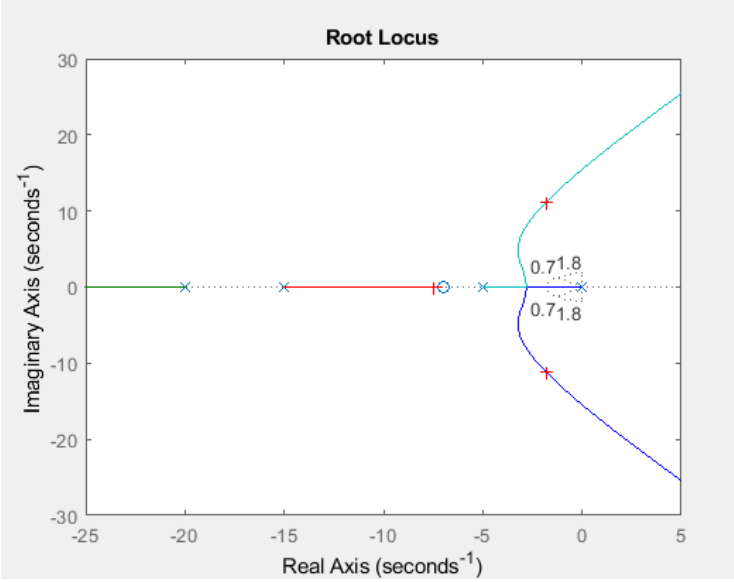
- A program for Root locus is written and the program is saved in a folder.
- After saving the program. The program is made to run and any error occurred is corrected and the program is run again.
- The root locus graph is displayed. A random point on the root locus is chosen and k values and the poles are displayed in the output.
- Then the calculated values of k, Natural frequency and damping ratio are entered in the program. The rise time and Peak Overshoot values are obtained from the output graph.
- Then a Control system is designed using the code controlSystemDesigner Plant and then compensated as for our needs.
- The Rise time and Settling time characteristics are displayed on the output by
  Right click → Properties → Characteristics
  - Rise Time
  - Settling Time
- After obtaining the graph, the required output is snipped using snipping tool and the program is closed.

Matlab Code:

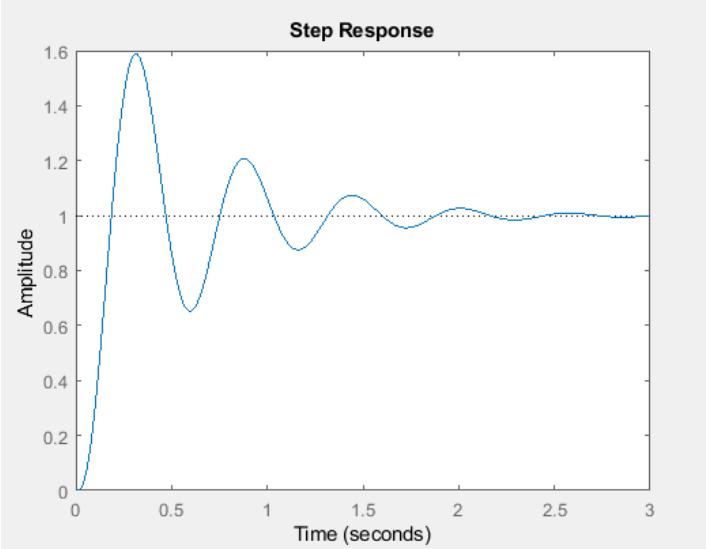
```
sys= (s+7)/(s*(s+5)*(s+15)*(s+20));
rlocus(sys)
axis([-22 3 -15 15])
zeta= 0.7;
wn= 1.8;
sgrid(zeta,wn)
[k,poles]= rlocfind(sys);

sys_cl=feedback(k*sys,1);
step(sys_cl);
s=tf('s');
plant= (s+7)/(s*(s+5)*(s+15)*(s+20));
controlSystemDesigner(plant)
```

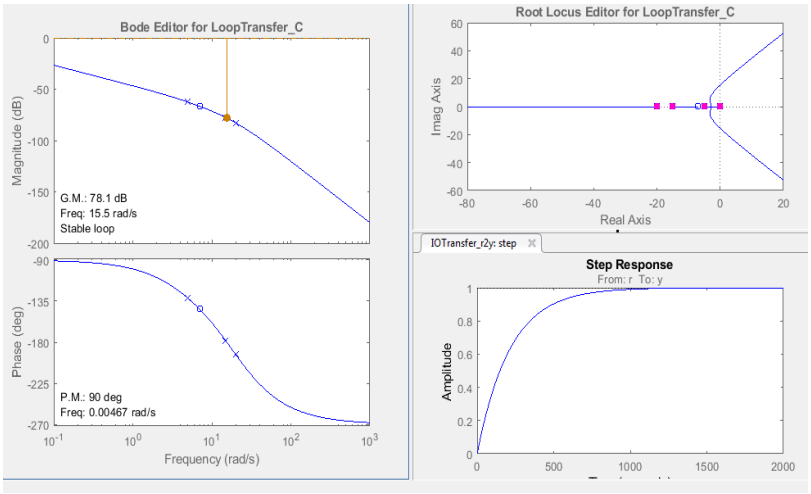
Output:



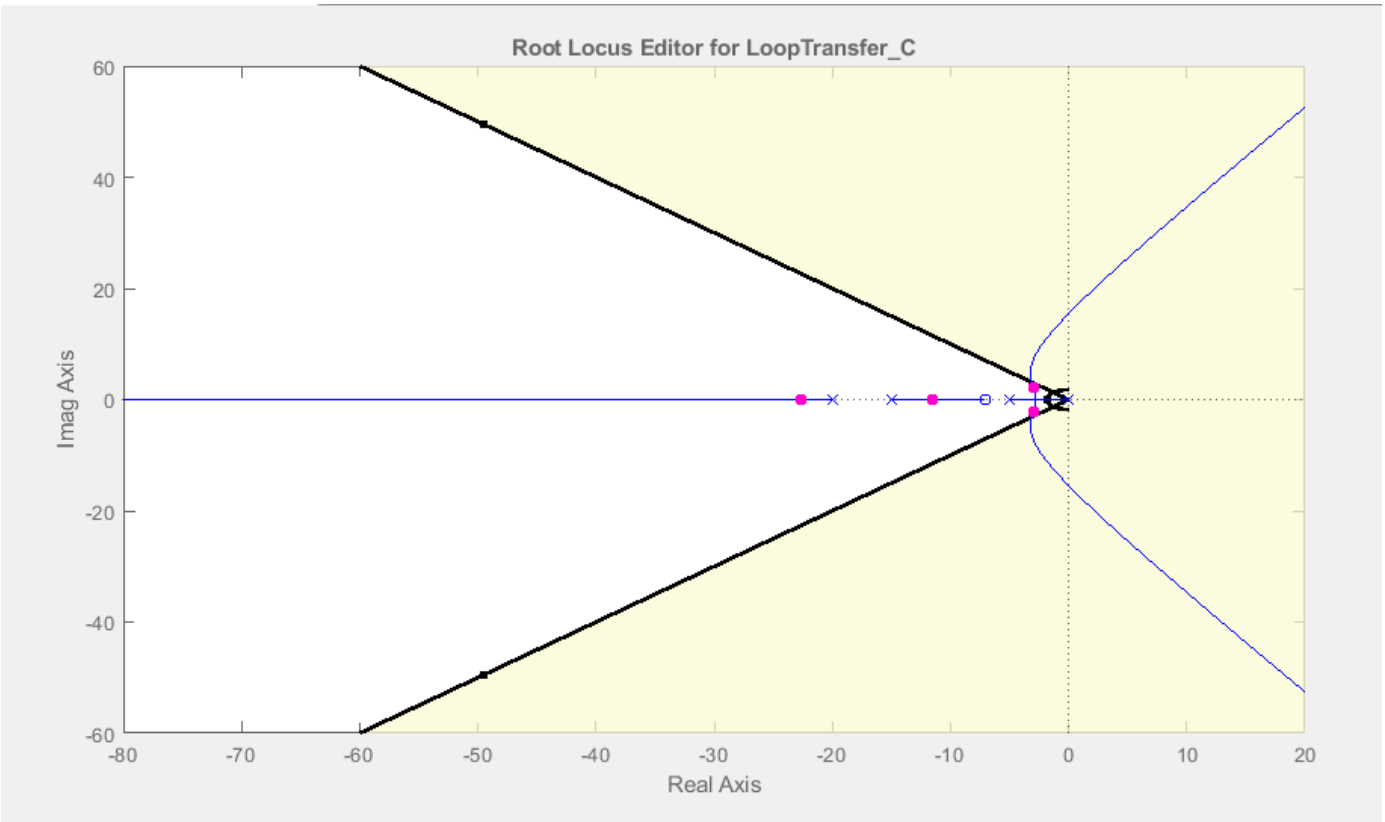
Rise Time and Peak Time:



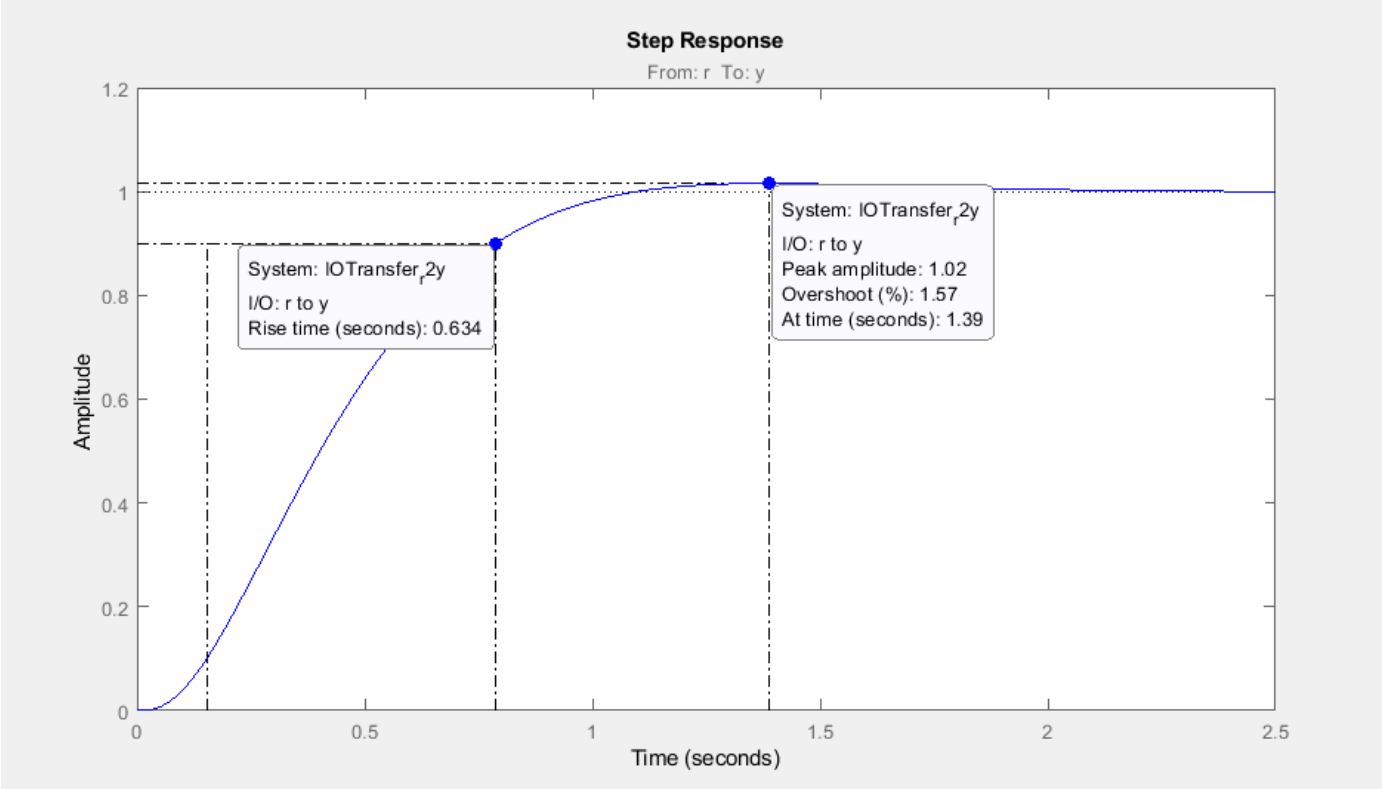
Control System Designer:



Root Locus:



Step Response:



Inference:

On the Software:

On the Procedure:

Result: