Ex. No:	**Root Locus based analysis in simulation platform**
Date:	

Aim:

To perform Root Locus based analysis in a simulation platform.

Introduction to Root Locus Technique:

The Root Locus Technique is a powerful and graphical method used in control system engineering to analyze the behavior of a closed-loop control system as a parameter, typically a proportional gain or a complex variable, is varied. It provides valuable insights into how changing system parameters affect the stability and transient response of a control system.

The fundamental concept behind the Root Locus Technique is to plot the trajectories of the closed-loop poles of the system as a parameter is adjusted. These poles represent the characteristic roots of the system's transfer function, and their locations in the complex plane directly influence system behavior. By visualizing the movement of these poles, engineers can make informed decisions to design a control system that meets desired performance specifications.

1. Open-Loop Transfer Function:To begin, you must have the open-loop transfer function of the system. This transfer function captures the relationship between the input and the output of the system before feedback is applied.

2. Closed-Loop Poles: The technique focuses on determining the locations of the closed-loop poles. The stability and transient response of the system depend on the positions of these poles.

3. Parameter Variation: Typically, the parameter being varied is a proportional gain (K), but it can also be other system parameters, such as time constants or damping ratios.

4. Complex Plane: The complex plane is used to represent the possible locations of the closed-loop poles. The real part of the poles positions corresponds to the system's damping and speed of response, while the imaginary part affects the system's oscillatory behavior.

5. Root Locus Plot: By varying the parameter over a range, you can create a Root Locus Plot, which is a graphical representation of the pole trajectories as the parameter changes. This plot helps you visualize how changes in the parameter affect system stability.

6. Stability Analysis: The Root Locus Plot can quickly indicate whether the system is stable, marginally stable, or unstable for different parameter values. Stable systems have poles with negative real parts.

7. Design Insights: Engineers can use the Root Locus Technique to design control systems that meet specific performance criteria, such as desired damping ratios, settling times, or overshoot limits. By adjusting the parameter value, they can shape the locus to meet these goals.

8. Iterative Process:Root locus analysis often involves an iterative process of adjusting the parameter and observing the pole movement until the desired system behavior is achieved.

Procedure:
Step 1. To locate the open loop poles and zeros
Step 2. Locate the root locus on real axis
Step 3. Find the angle of asymptote and centroid
Step 4. To find break away or break in points
Step 5. Determine angle of departure or angle of arrival if conjugate pole pairs are present.
Step 6. Find the point of intersection at the imaginary axis and its corresponding gain.

Problem 1:

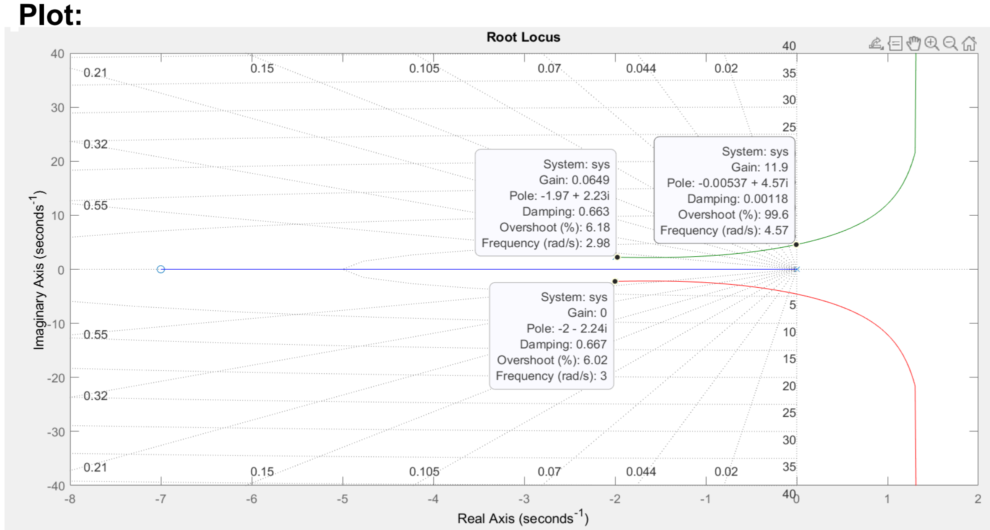
Matlab code:

```
clearvars;
close all;
%% Transfer function
sys = tf([1 7],[1 4 9 0]);
P = pole(sys);
disp(P)
rlocus(sys);
[r,k] = rlocus(sys,k)
% returns poles at different gain values
%k= 1:1:100; % user defined gain values
whos
% Get crossover gain from the plot and use the value in simulation
```

Output:

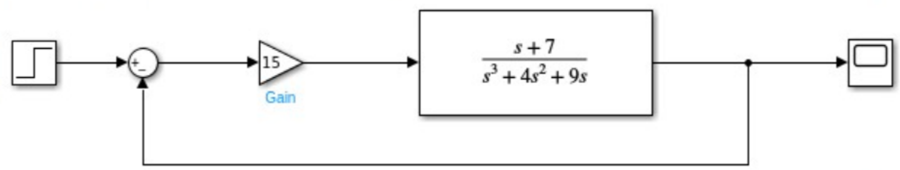
Root locus:
  0.0000 + 0.0000i
 -2.0000 + 2.2361i
 -2.0000 - 2.2361i

Plot:



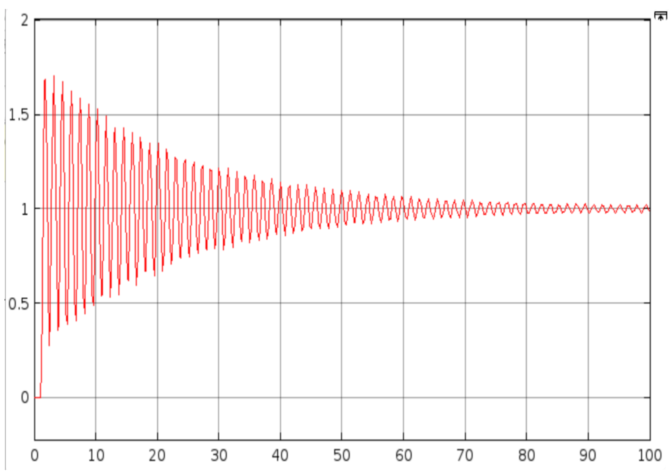
Inference:

Simulation:

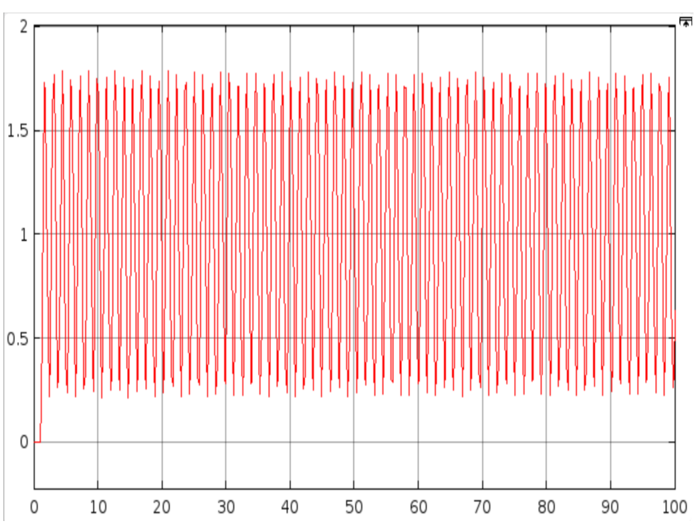


Simulation results:

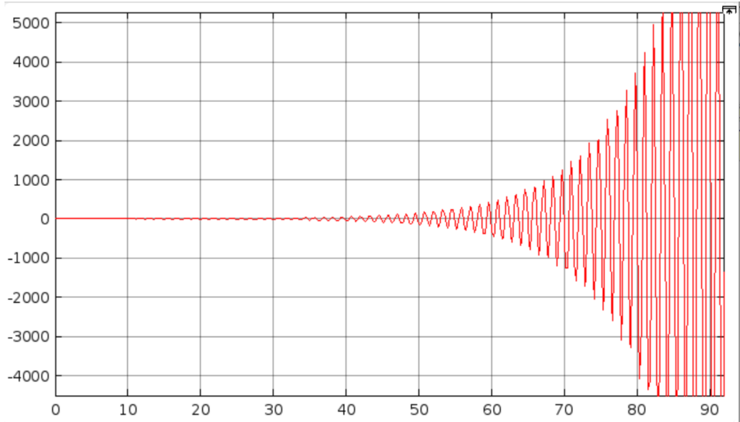
For k = 11 | **Inference:**



For k = 12 | **Inference:**



For k = 15 **Inference:**



Problem:2

Matlab code:

```
clearvars;
close all;
%% Transfer function
sys = tf([1],[1 6 8 0]);
P = pole(sys);
disp(P)
rlocus(sys);
%%
% returns poles at different gain values
k= 1:1:100; % user defined gain values
[r,k] = rlocus(sys,k);% k can be default also ( positive to inf)
whos
% Get cross over gain from the plot and use the value in simulation
```

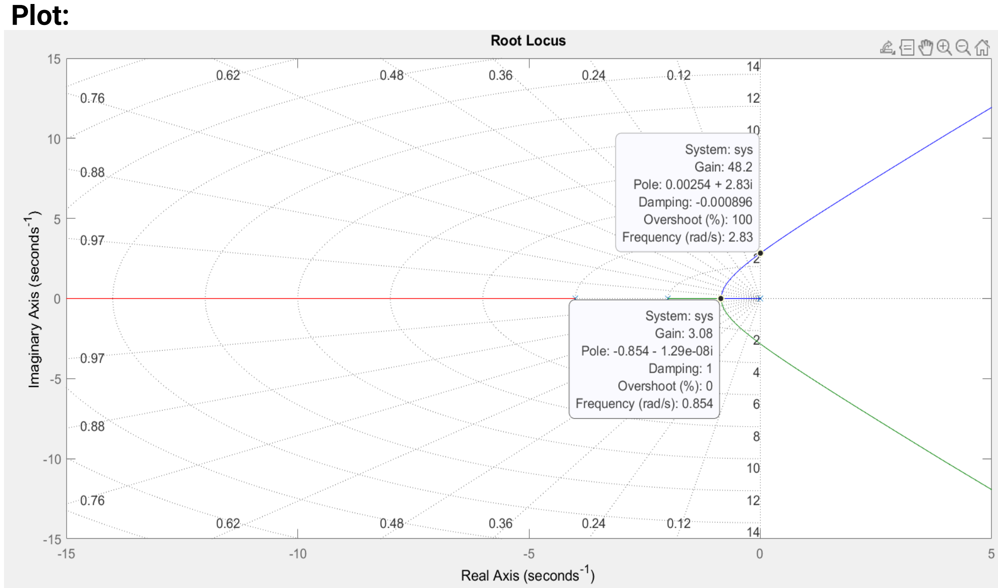
Output:

Root locus:

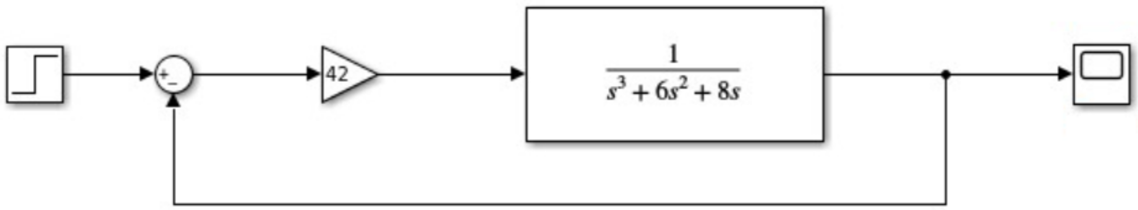
0
-4
-2

Inference:

Plot:

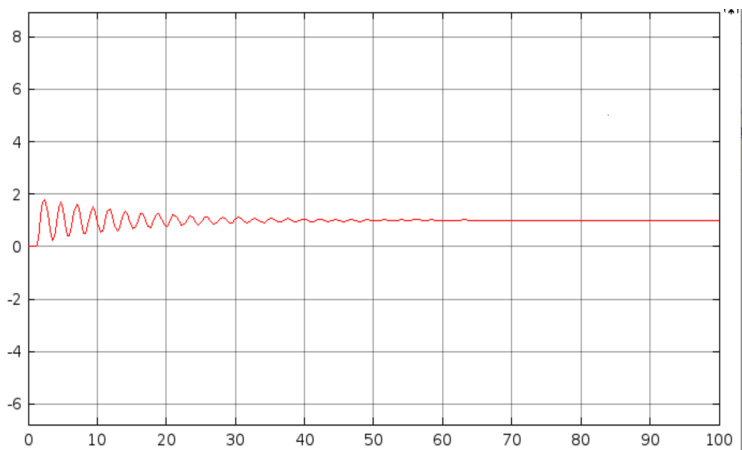


Simulation:

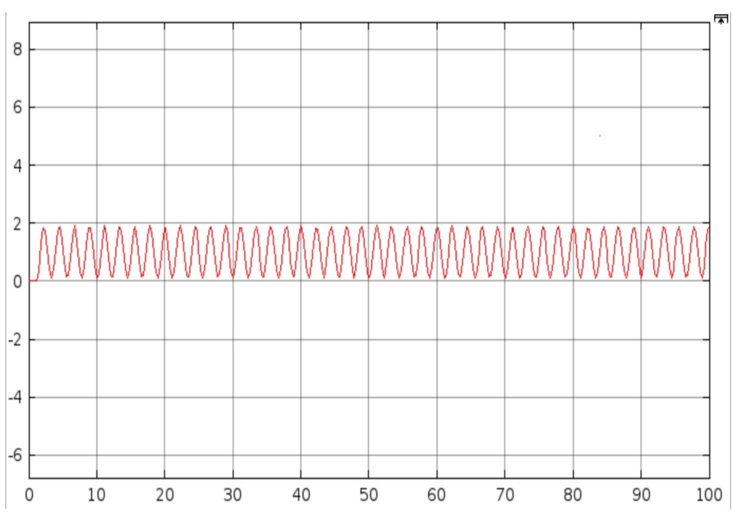


Simulation result:

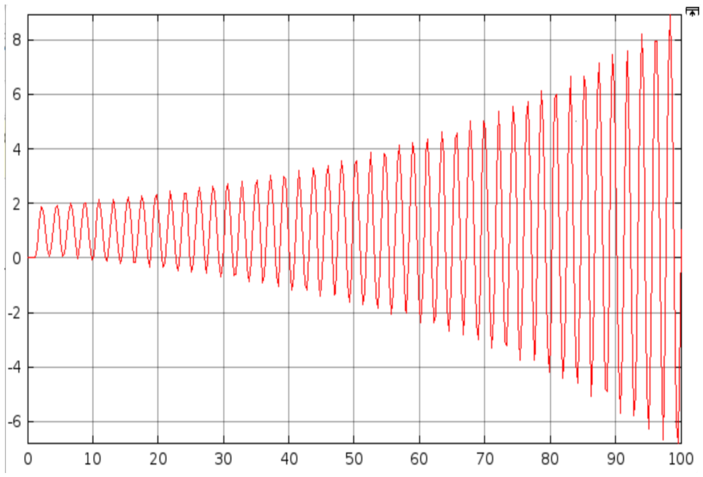
For k = 42 **Inference:**



For k = 48 **Inference:**



For k = 50 **Inference:**



Result:

Thus Root Locus based analysis in a simulation platform is performed and verified using Matlab code.