Control Systems LAB Digital Assignment 2

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Course: **EEE-3001**

Course Name: **Control Systems Lab**

Lab Slot: **L45 + L46**

Stability Determination of a System by Root – Locus Plot

Exp No: 2

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AIM

1. To analyze the stability of the system given in transfer function model by Root Locus using M-file Editor in MATLAB.

APPARATUS REQUIRED

1. Personal Computer with MATLAB

THEORY

1. The root locus technique is a powerful tool for adjusting the location of closed loop poles to achieve the desired system performance by varying one or more system parameters.
2. The path taken by the roots of the characteristics equation when open loop gain K is varied from 0 to is called root locus. Root locus technique is a graphical method for sketching the locus of roots in the s – plane as a parameter is varied.

PROCEDURE

1. Enter the command window of the MATLAB.
2. Create a new M – file by selecting File – New – M – File.
3. Type and save the program.
4. Execute the program by either pressing F5 or Debug – Run.
5. View the results.
6. Analysis the stability of the system.

PROBLEM STATEMENT

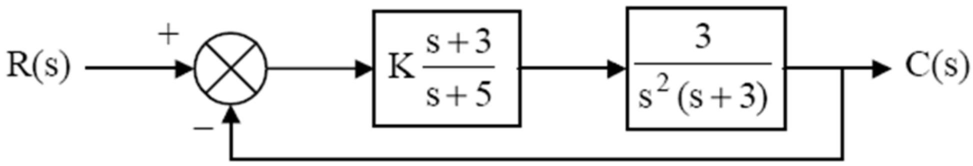
1. A plant to be controlled is described by a transfer function G(s) $= \frac{s+5}{s^2+7s+25}$. Obtain the root locus plot using MATLAB

2. A unity-feedback control system is defined by the following feedforward transfer function G(s) $= \frac{k}{s(s^2+5s+9)}$

   (a) Determine the location of the closed-loop poles, if the value of gain is equal to 3.

   (b) Plot the root loci for the system using MATLAB.

3. For the control system shown in Fig. below:



   (a) Plot the root loci for the system

SOLUTION

1. code 1

```
num=[1 5];
den=[1 7 25];
rlocus(num,den)
```

2. code 2

```
num=1;
den=[1 5 9 0];
rlocus(num,den)
```

3. code 3

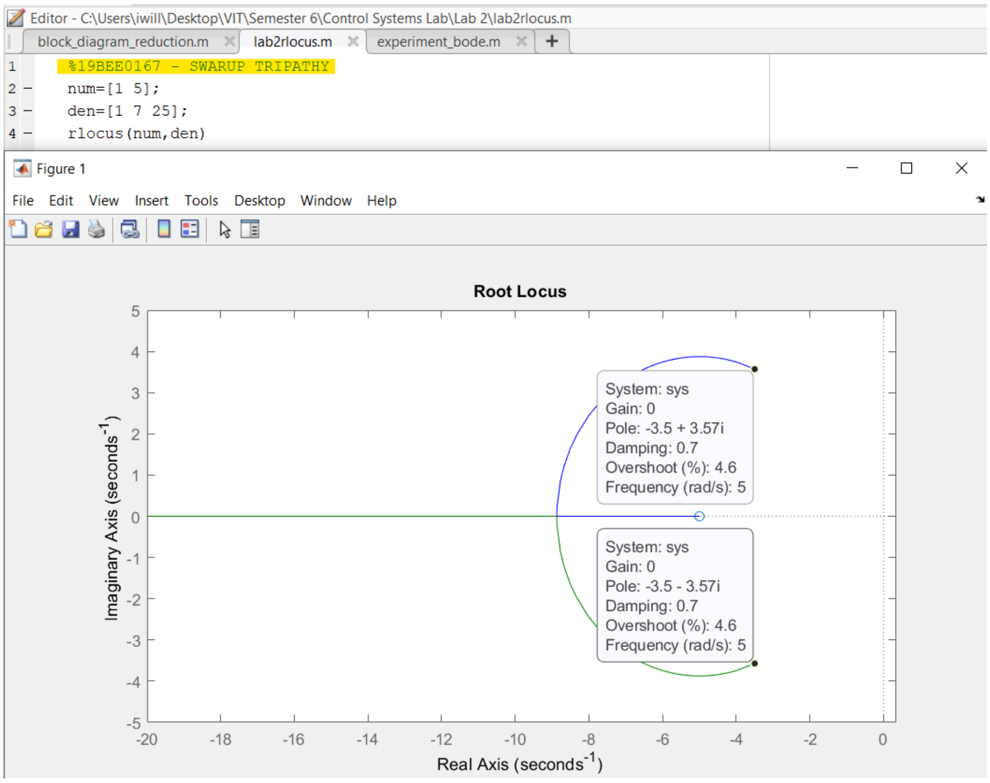
   (a) The open-loop transfer function G(s) is given by

$$G(s) = K\frac{s+3}{s+5}\,\frac{3}{s^2(s+3)} = \frac{3K(s+3)}{s^4+8s^3+15s^2}$$

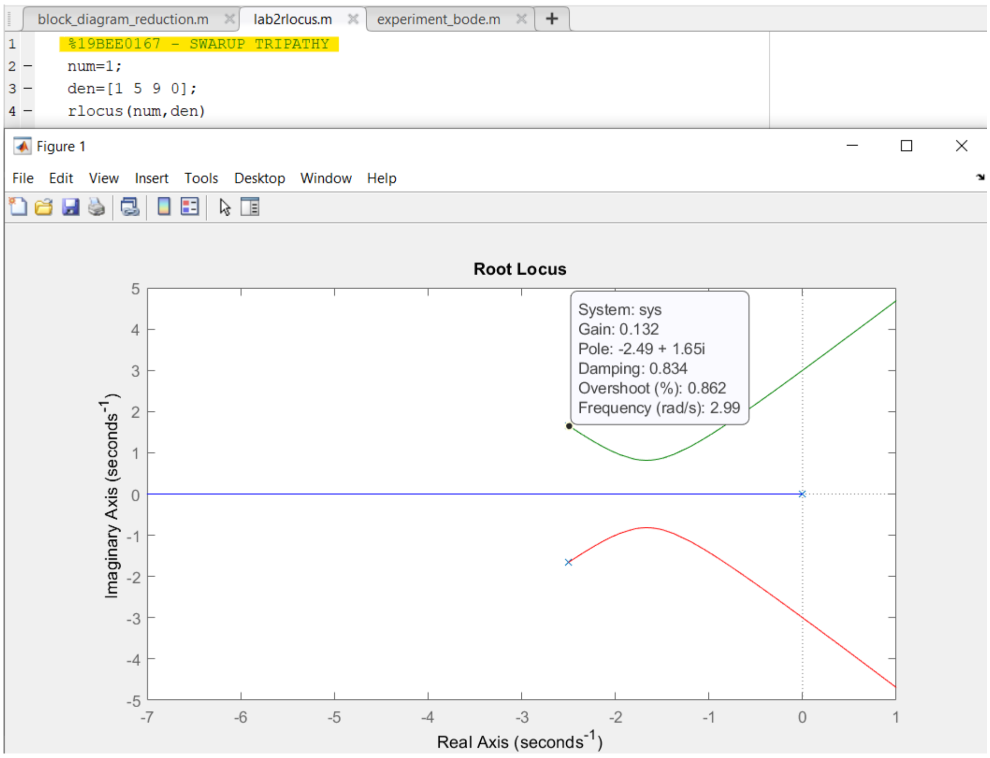
```
num=3;
den=[1 5 0 0];
rlocus(num,den)
```

SYSTEM RESPONSE

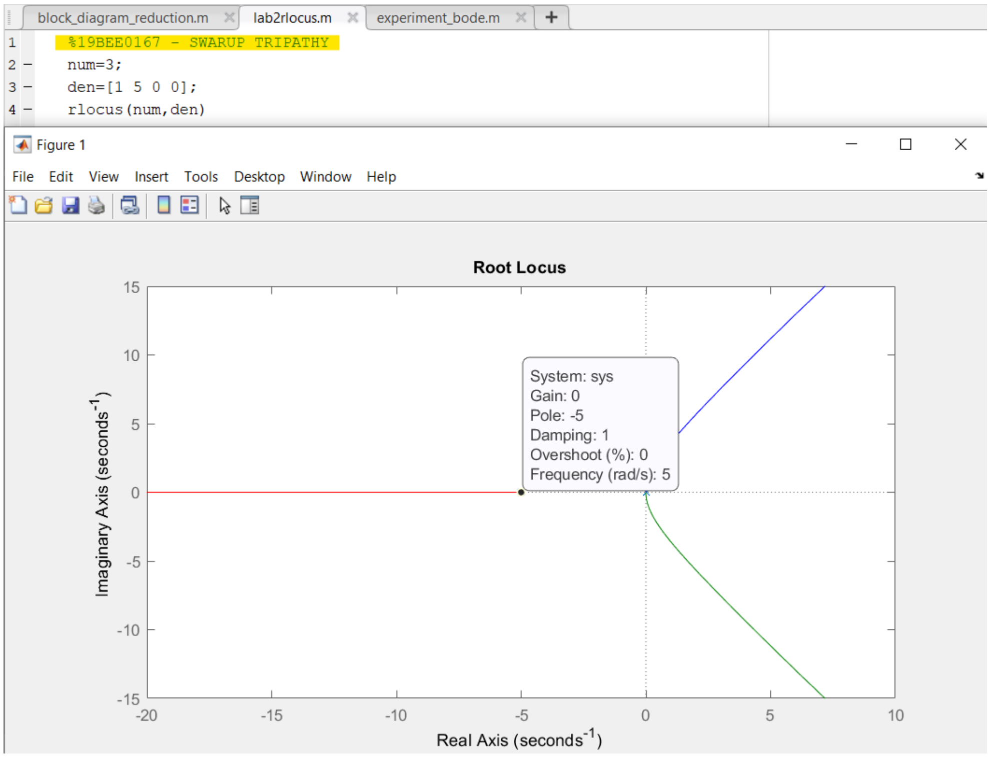
1. Response for Code 1



2. Response for Code 2



3. Response for Code 3



POSSIBLE INFERENCES

1. As we increase the gain the system moves from the over-damped to the under-damped mode.
2. Further increase in gain reduces the damping ratio which has the effect of
   (a) Increasing the damped frequency of oscillation (imaginary part of the closed loop pole)
   (b) Increasing the peak overshoot. (Since s decreases as cos-1s increases)
   (c) Reducing the steady state error (if it is not already zero)
3. The settling time depends on the real part of the closed pole (A constant -swn in this case).
4. The number of roots depends on the order of the system. Each root starts from an open loop pole and goes to infinity towards asymptotes at +900 .(Here the number of asymptotes equal the number of open loop poles since there are no zeros).
5. The closed loop poles remain in the left half plane and a second order system is always stable in the closed loop. (Provided it is stable in the open loop)