EXERCISE 4

ROOT LOCUS

Date: ***Reg. No. :***

LAB PREREQUISITES:

Exercise 1 to 3

PREREQUISITE KNOWLEDGE:

Fundamentals of MATLAB programming

OBJECTIVES:

The objective of this exercise is to plot the root locus of given system and determine the gain for obtaining the different peak overshoots using MATLAB and SIMLINK

PRELAB:

Draw the roots locus for the given open loop transfer function.

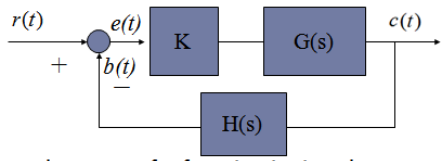
READINGS:

Introduction to Root Locus:

Application of the many classical and modern control system design and analysis tools is based on mathematical model. MATLAB can be used with systems given in the form of transfer function description. We are interested in how MATLAB can assist us in determining

- the number of branches.
- the starting and ending points of all the branches.
- the intersections of the root loci with the imaginary axis and the corresponding value of K.
- the system's oscillating frequency associated with the gain K.
- the breakaway points.
- the value of K at breakaway point.

For any given system G(s) the following figure illustrates a closed loop proportional control.



The open loop transfer function is given by

$$\frac{B(s)}{E(s)} = K\,G(s)H(s)$$

The closed loop transfer function is given by:

$$\frac{C(s)}{R(s)} = \frac{K\,G(s)}{1+K\,G(s)H(s)}$$

The root locus of an (open-loop) transfer function is a plot of the locations (locus) of all possible closed loop poles with proportional gain K and unity feedback.

Independently from K, the closed-loop system must always have *n* poles, where *n* is the number of poles of the open loop transfer function. The root locus must have *n* branches; each branch starts at a pole of the Open Loop Transfer Function (OLTF) and goes to zero of OLTF. If OLTF has more poles than zeros (as is often the case), m < n and we say that the OLTF has zeros at infinity. In this case, the limit of OLTF as s → infinity is zero. The number of zeros at infinity is n-m, the number of poles minus the number of zeros, and is the number of branches of the root locus that go to infinity (asymptotes). Since the root locus is actually the locations of all possible closed loop poles, from the root locus we can select a gain such that our closed-loop system will perform the way we want. If any of the selected poles are on the right half plane, the closed-loop system will be unstable. The poles that are closest to the imaginary axis have the greatest influence on the closed-loop response, so even though the system has three or four poles, it may still act like a second or even first order system depending on the location(s) of the dominant pole(s).

PROGRAMS, OBSERVATIONS AND INFERENCES

1. **Write the Matlab codes for drawing root locus of the given open loop system G(s)=$\frac{k}{s(s+1)(s+2)}$ and draw the output response for the desired poles selected from the root locus.**

2. **Write the Matlab program for calculating the gain for the given peak over shoot value and also draw the step response for the calculated gain value.**

PROGRAM

```
clc;
clear all;
close all;
num=[1];
den=[1 3 2 0];
sys=tf(num,den)
cl_sys=feedback(sys,1)
figure(1);
step(cl_sys);
figure(2);
rlocus(num,den);
z=input('Enter the value for zeta');
w=input('Enter the value for omega n ');
sgrid(z,w);
[k,poles]=rlocfind(num,den);
new_clsys=feedback(sys*k,1)
figure(3);
step(new_clsys);
```

RESULTS & INFERENCES:

Evaluation Component	Maximum Marks	Marks Obtained
Pre-lab Tasks	10	
In-Lab Tasks	20	
Post-lab Tasks	10	
Bonus Tasks	10	
Signature of Faculty with Date		

(This page must be the last page of the exercise)