



**ANKARA UNIVERSITY**  
**Engineering Faculty**  
**Department of Electrical and Electronics Engineering**

## **Experiment-6**

### **EEE 360 Control Lab**

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#### **ROOT LOCUS METHOD**

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#### **Objectives of the Experiment:**

- Learn basics of LabVIEW
- Construct feedback control systems on LabVIEW environment and construct root locus plot
- Understand the importance and sketch root locus.
- Learn the Simulation window and related topics of LabVIEW

### 1.Preliminary Study:

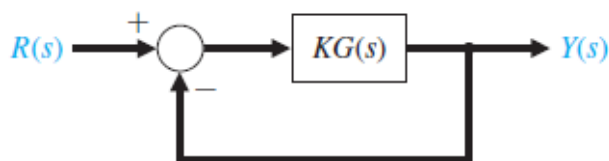
- 1.Please read experimental study section to understand what you are going to do in the experiment.
- 2.Research on related topics in computer programs like Matlab or Scilab. Prepare yourself for the next questions and experiment. Learn and read related documents to understand the experiment.
3. Using the rlocus function, obtain the root locus for the following transfer functions of the system shown in Figure

$$(a) G(s) = \frac{25}{s^3 + 10s^2 + 40s + 25}$$

$$(b) G(s) = \frac{s + 10}{s^2 + 2s + 10}$$

$$(c) G(s) = \frac{s^2 + 2s + 4}{s(s^2 + 5s + 10)}$$

$$(d) G(s) = \frac{s^5 + 6s^4 + 6s^3 + 12s^2 + 6s + 4}{s^6 + 4s^5 + 5s^4 + s^3 + s^2 + 12s + 1}$$

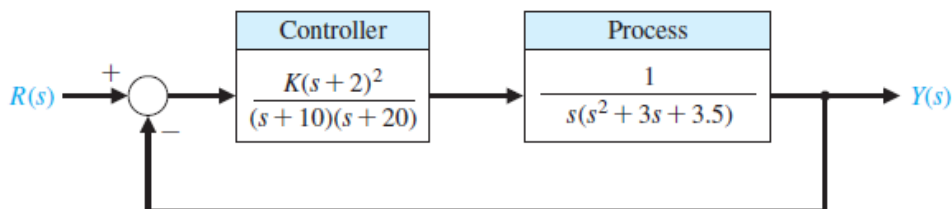


4. Compute the partial fraction expansion of

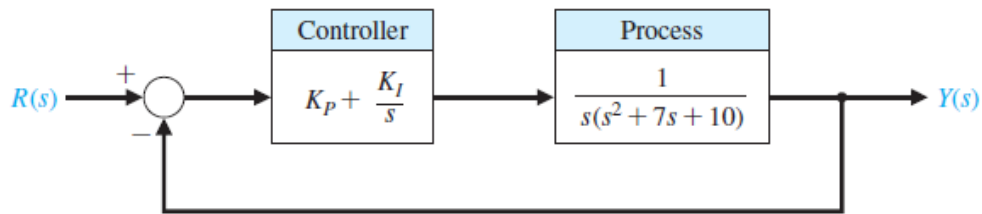
$$Y(s) = \frac{s + 6}{s(s^2 + 6s + 5)}$$

and verify the result using the residue function.

5. A control system is shown in Figure. Sketch the root locus, and select a gain K so that the step response of the system has a percent overshoot of P.O<10%, and the settling time (with a 2% criterion) is  $T_s < 4$  s.



6. A control system with PI control is shown in Figure. (a) Let  $K_I / K_P = 0.2$  and determine  $K_P$  so that the complex roots have maximum damping ratio. (b) Predict the step response of the system with  $K_P$  set to the value determined in part (a).



## 2.Experimental Study:

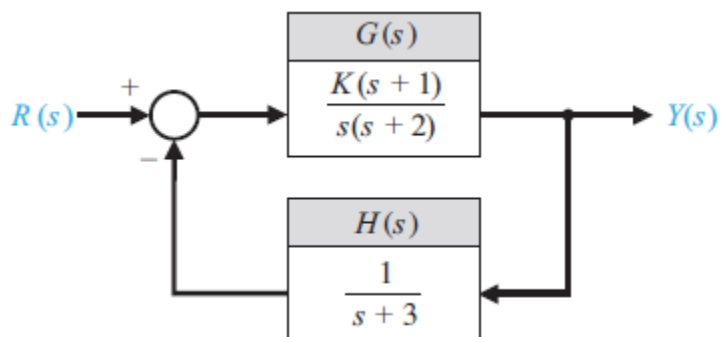
This section is given in two parts. The application in the first part (Repeat the Steps) is expected to be repeated by the student and to find the same result obtained. Thus, the student understands the subject and learns how to use it. In the second part (Do it Yourself), the jobs to be done are listed, but they are not explained how to do them. He solves and fills in the datasheet using the information (s)he learned in the first part and what he did in the preliminary study.

Look at the previous experiment's documents. Be sure you learn every step at the previous experiments. You may need the information from the previous experiment.

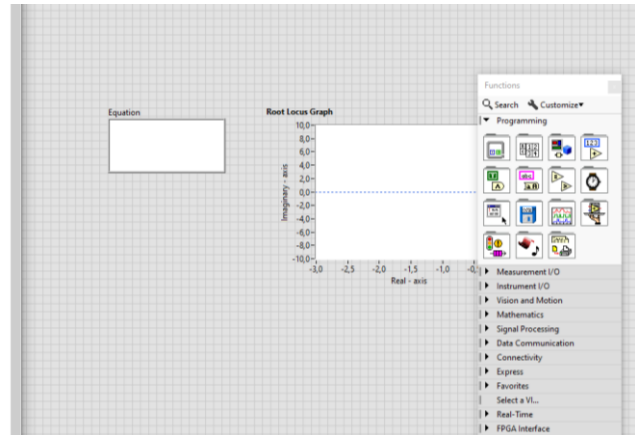
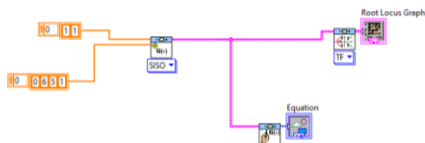
### 2.1. Repeat the Steps

Consider the closed-loop control system in Fig. The general form of the characteristic equation necessary for application of the CD Root Locus function is

$$1 + K \frac{p(s)}{q(s)} = 0,$$



The CD Root Locus function is used to obtain the root locus plot associated with Eq. For the characteristic equation, the associated root locus plot is shown in Fig. The steps required to use CD Root Locus to obtain a root locus plot with LabVIEW are as follows: i) Obtain the characteristic equation, ii) Use the CD Root Locus function to generate the plots. Construct the block diagram and corresponding front panel as given in the Fig.



## **2.2. Do it Yourself!**

1. Obtain root locus plot in LabVIEW environment

- a. Repeat question 3 in preliminary work in LabVIEW environment
- b. Repeat question 5 in preliminary work in LabVIEW environment

2. Why root locus is important?

3. In question 3a in preliminary work, assume that 25 can be a variable between 20-30. Show the system sensitivity

- a. By using analytical calculations
- b. from the root locus plot in Matlab (or Scilab)
- c. from the root locus plot in LabVIEW

## **Report:**

1. Please answer all the questions give in experimental study. Please use Data Sheet you obtained from the experiment.

2. Re-make the calculations in preliminary study questions and compare the analytical results and computer output.

3. What is sensitivity? Why it is important? How can you improve the robustness of the system?