

## Laboratory 7: Root Locus

### Problem 15:

We consider the basic feedback loop with the open-loop transfer function  $G_o(s) = K \frac{1}{s(s^2 + 2s + 5)}$ .

- a. Sketch the root locus of for  $G_o(s)$ .  
Hint: Also find the intersection of the root locus with the imaginary axis
- b. Assume you want one pole at  $s = -2$ . Find the corresponding gain  $K$
- c. For the gain in **b.**, find the other two poles of the closed loop. Is the closed loop stable for this choice of  $K$ ?
- d. Verify your results using the command `rlocus` in Matlab.
- e. Simulate a reference step response of the feedback loop for  $K$  in **b.**

### Problem 16:

We consider the basic feedback loop with the open-loop transfer function  $G_o(s) = K \frac{(s + 3)(s + 1)}{s(s^2 + 3s + 5)}$ .

- a. Sketch the root locus plot for  $G_o(s)$ . What can you say about internal stability of the closed-loop system?
- b. How does the root locus plot change if the zero of  $G_o(s)$  at  $-1$  is located at  $+1$  instead? What can you say about internal stability of the closed-loop system?
- c. Verify your results using Matlab. Determine the closed-loop poles for 3 values of  $K$ .
- d. Simulate a reference step response for the values of  $K$  in **c.**

### Problem 17:

We consider the following plant transfer function in the basic feedback control loop

$$G(s) = \frac{2}{(s + 1)(s + 5)}$$

We want to use a controller with the transfer function

$$C(s) = K_p \frac{s + n}{s}$$

and we want to achieve the following performance specification

- The damping should be between 0.6 and 0.7
- a. Choose  $n$  such that the controller zero cancels the slowest plant pole
  - b. Sketch the root locus plot of  $C(s)G(s)$
  - c. Sketch the performance specification in your root locus plot
  - d. Mark the part of the root locus plot that fulfills the performance specification
  - e. Use Matlab to find a value of  $K$  such that the closed loop fulfills the performance specification.
  - f. Simulate a reference step response for the value of  $K$  in **e.**