Master study
Systems and Control Engineering
Department of Technology
Telemark University College
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SCE1106 Control Theory

Exercise 8

Task 1

We are in this exercise going to study the same system as in Exercises 6 and 7. The system is described by the model

$$h_p(s) = \frac{e^{-2s}}{s^2 + 3s + 2}. \tag{1}$$

The system is to be controlled by a PI controller of the form

$$h_c(s) = K_p \frac{1 + T_i s}{T_i s}. \tag{2}$$

a) Assume that the PI controller is substituted with a P controller. Write down an expression for the loop transfer function, $h_0(s)$. Find the phase crossover frequency, ω_{180}, and the critical gain K_{cu}. Note that the critical gain, K_{cu}, is the value on K_p which results in that the system is at the stability limit, i.e. such that $|h_0(j\omega_{180})| = 1$. The system has then a Gain Margin $GM = 1$.

b) Find K_p and T_i by the Ziegler-Nichols method. Write down an expression for the PI controller in the time domain.

c) Write down an expression for the loop transfer function with the PI controller as found in subtask b) above in the loop.

1. What is the Gain Margin, GM, for the closed loop system?
2. What is the Phase Margin, PM, of the system. ?

You can with advantage use the Control System Toolbox function **margin**.

d) Simulate the closed loop system after a unit step response in the reference signal. Compare the PI controller settings found in this exercise with the Skogestad settings from Exercise 6 and the settings found in Exercise 7. You can with advantage use the MATLAB script **losn7_oppg1.m** from Exercise 7.