

**Exercise Sheet 1: Linear Systems and Nonlinear Systems****Problem 1:**

We want to recall some basic facts about linear control systems.

- a. Consider the plant transfer function  $G(s) = \frac{s^2 + 4s + 5}{(s + 4)(s^2 + 5s + 2)(s^2 - 2s + 5)}$ . What is the relative degree of  $G(s)$ ? Is the plant stable?
- b. Consider the transfer function  $G(s) = \frac{5}{s^2 + 2s + 4}$ . Why is this transfer function oscillatory? Sketch the step response of  $G(s)$ !
- c. Consider the basic feedback loop with the plant transfer function  $G(s) = \frac{1}{1 + s}$  and the controller transfer function  $C(s) = \frac{2 + s}{s}$ . Is the closed loop stable? Does the closed loop have a zero steady-state error?

**Problem 2:**

We want to classify the following plant models

$$\begin{aligned} \dot{x}_1 &= x_1 - x_1^2 + x_2 + 4u \\ \text{(a)} \quad \dot{x}_2 &= -x_2 \\ y &= 3x_2 \end{aligned}$$

$$\text{(b)} \quad G(s) = \frac{(s^2 + s + 1) \cdot e^{-5s}}{(s + 1)(s + 5)(s + 2)}$$

$$\begin{aligned} \dot{x}_1 &= x_1 + 5x_2 \\ \text{(c)} \quad \dot{x}_2 &= -x_2 + 3u \\ y &= 23x_2 \end{aligned}$$

Decide which of the plant models is linear/nonlinear.