Course „Control Systems 2“

Exercise Sheet 4

Task 13:

Consider the following nonlinear first-order system

$$\dot{x} = k_1 e^{\frac{k_2}{x}} - k_3 u$$
$$y = \arctan(x)$$

where k_1, k_2 and k_3 are positive real constants.

a) Show that the system has one equilibrium point for each constant input $u_{OP} > 0$ (except for $u_{OP} = \frac{k_1}{k_3}$) and state this equilibrium point as a general expression depending on u_{OP}.

b) Is it possible to linearize the system around all these equilibrium points? Why (not)?

c) Determine the linearized system descriptions around the equilibrium points. Take the dependency on the equilibrium point into account by expressing all parameters of the linearized system as functions of u_{OP}.

Task 14:

Consider the following nonlinear SISO system

$$\underline{\dot{x}} = \begin{bmatrix} 2x_1^2 - 7x_2 + x_1 x_2 x_3 + u x_1 \\ 2x_1 + x_2 x_3 \\ x_1 x_2 + 4x_3 + u x_2 \end{bmatrix}$$

$$y = x_1 + 3x_3$$

a) Calculate the equilibrium point of the system at $x_{1,OP} = x_{2,OP} = 1$.

b) Determine the linearized state equations around this equilibrium point and state them in matrix form.