Project #4: Feedback Linearizing Control

ELEC 7560/7566 – Summer 2017

Due: Wednesday, August 2

Problems come from Chapter 6 of Jean-Jacques E. Slotine and Weiping Li. *Applied Nonlinear Control*. Prentice-Hall, 1991.

1 Input-output linearization

(30 pts) Consider the system

$$\begin{aligned} \dot{x}_1 &= x_2^3 + u \\ \dot{x}_2 &= -u \\ y &= x_1 \end{aligned} \tag{1}$$

Design an input-to-output linearizing control that yields a closed loop eigenvalue at -1. Then analyze the internal dynamics. Note: The author claims the internal dynamics are unstable. Do you agree? Verify by computer simulation.

2 Input-output linearization

(30 pts) Design an input-output linearizing control to track a desired trajectory $x_{d1}(t)$. Assume the full state is measurable, and that all necessary derivatives of the desired trajectory are known. Verify by computer simulation.

$$\begin{aligned} \dot{x}_1 &= \sin x_2 \\ \dot{x}_2 &= x_1^4 \cos x_2 + u \\ y &= x_1 \end{aligned} \tag{2}$$

3 Input-state linearization

(30 pts) Design a stabilizing control law for

$$\begin{aligned} \dot{x}_1 &= x_1 - x_1 u_1 \\ \dot{x}_2 &= (1 - \ln x_3) x_2 - x_2 u_1 \\ \dot{x}_3 &= -x_1 x_3 - x_3 u_1 + u_2 \end{aligned} \tag{3}$$

Use the coordinate transformation $z_1 = \ln(x_1/x_2), z_2 = \ln x_3, z_3 = \ln x_1$. Hint: In the new coordinates, treat the system as two subsystems, one first order and the other being second order. Use control u_1 to stabilize one subsystem, and u_2 to stabilize the other subsystem. Verify by computer simulation.