

Lab No. 02

Feedback Linearization Control

Exercise 01

Consider the following nonlinear system:

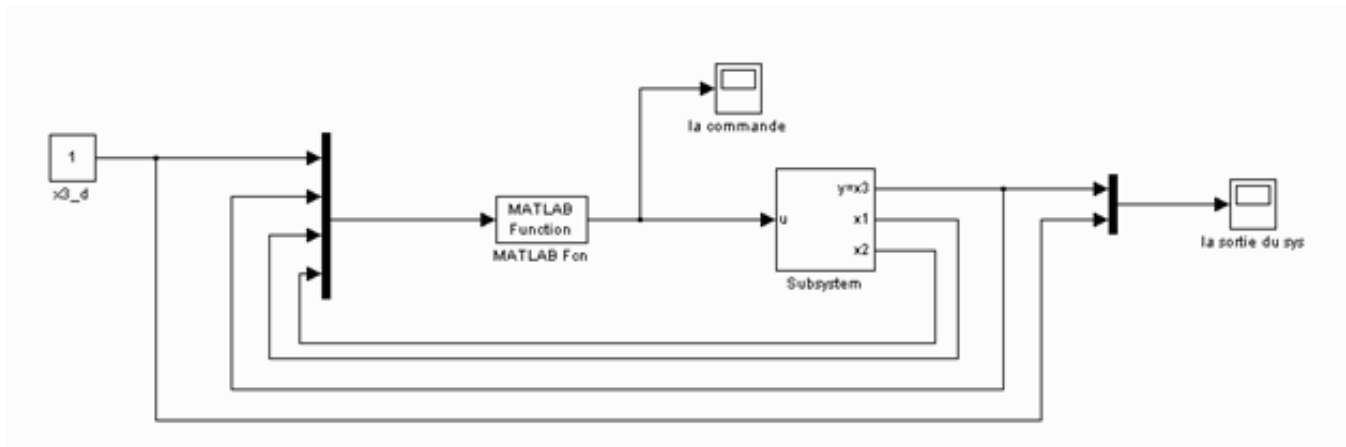
$$\dot{x} = \begin{pmatrix} 0 \\ x_1 - 0.5x_2^2 \\ x_1 - x_2 \end{pmatrix} + \begin{pmatrix} e^{x_2} \\ -e^{x_2} \\ 0 \end{pmatrix} u$$

$$y = h(x) = x_3$$

Synthesize the control using feedback linearization with the following control gains:

$k_1=8$, $k_2=17$, $k_3=0.1$

Closed-loop Simulation:



Create a program (Matlab Function) for the control law given by:

```
function out=command(in)

x_3_d=in(1);
x_3=in(2);
x_1=in(3);
x_2=in(4);

U=(8*(x_3-x_3_d)+17*(x_1-x_2)+0.1*(-x_1+0.5*x_2^2)-x_2*(-.5*x_2^2+x_1))/(exp(x_2)*(-x_2-1))

out=U
```

Exercise 02

Consider the following nonlinear system:

$$\begin{cases} \dot{x}_1 = x_2 \\ \dot{x}_2 = a_1 x_1 x_2 + a_2 x_2^2 + a_3 x_2 + 4u \\ y = h(x) = x_1 \end{cases}$$

With $a_1 = -0.8636$ $a_2 = -0.1454$ $a_3 = -0.0074$

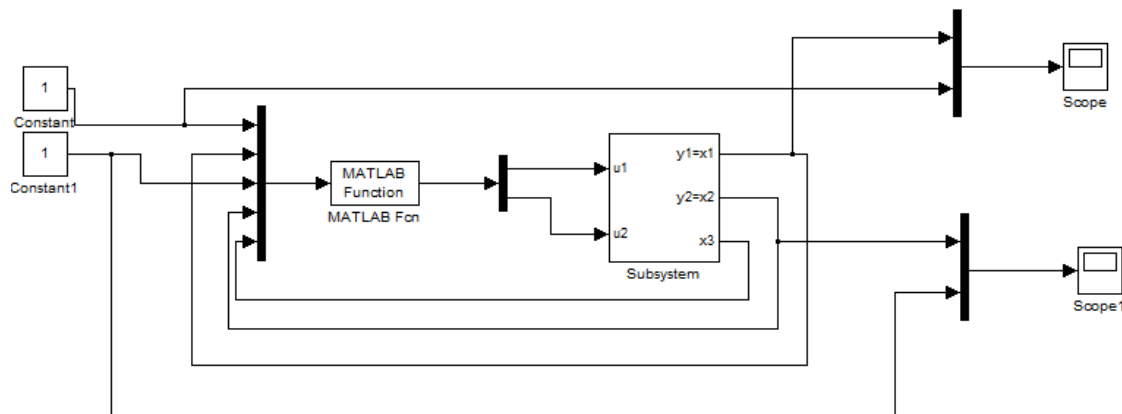
- The same questions as in exercise 01.

Exercise 03

Consider the following Nonlinear MIMO system:

$$\dot{X} = \begin{pmatrix} x_1 \\ x_3 \\ x_3 x_1 \end{pmatrix} + \begin{pmatrix} \cos(x_3) \\ 0 \\ 1 \end{pmatrix} U_1 + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} U_2$$
$$Y = \begin{pmatrix} h_1(x) \\ h_2(x) \end{pmatrix} = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

- Synthesize a control using feedback linearization.



```
function out=command3(in)
x_1_d=in(1);
y_1=in(2);
x_2_d=in(3);
y_2=in(4);
x_3=in(5);
u_1=-1/cos(x_3)*(2*y_1-x_1_d)
u_2=1/cos(x_3)*(2*y_1-x_1_d)-20*(y_2-x_2_d)-6*x_3

out(1)=u_1
out(2)=u_2
```