University Badji Mokhtar - Annaba, Engineering Faculty
Department of Electronics

Section : M1 Auto. Inf> Ind. 2022/2023

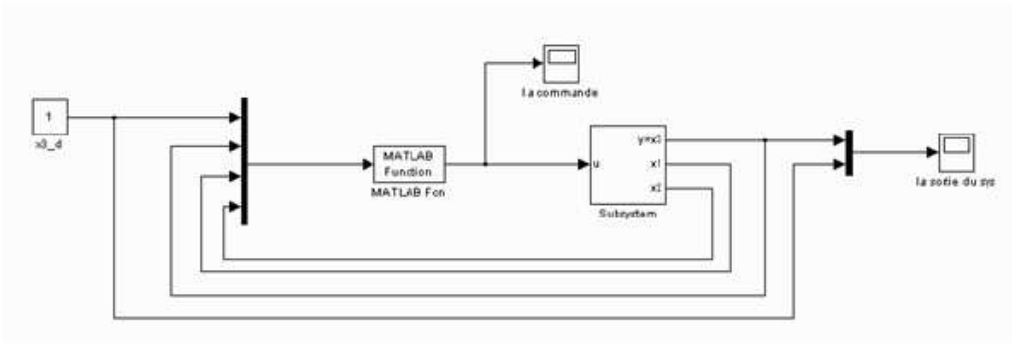
Course : Nonlinear systems

Lab 5 : Feedback linearization

Ex 1 : Consider the nonlinear system

$$\dot{x} = \begin{pmatrix} 0 \\ x_1 - 0.5x_2^2 \\ x_1 - x_2 \end{pmatrix} + \begin{pmatrix} e^{x_2} \\ -e^{x_2} \\ 0 \end{pmatrix} u$$
$$y = h(x) = x_3$$

Closed loop simulation :




```
function out=commmande(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
```

Ex 2 : For the nonlinear system :

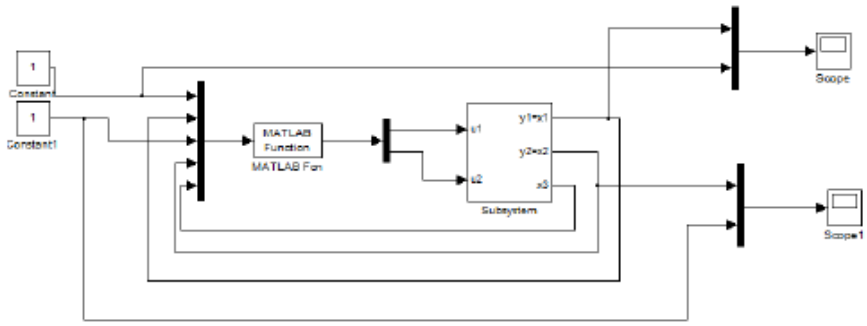
$$\begin{cases} \dot{x}_1 = x_2 \\ \dot{x}_2 = a_1 x_1 x_2 + a_2 x_2^2 + a_3 x_2 \end{cases}$$

$$a_1 = -0.8636, \;\; a_2 = -0.1454, \; a_3 = -0.0074,$$

Design the feedback linearization controller.

Ex 3 : Design the feedback linearization controller for the nonlinear system :

$$\dot{x} = \begin{pmatrix} x_1 \\ x_3 \\ x_3 x_1 \end{pmatrix} + \begin{pmatrix} \cos(x_3) \\ 0 \\ 1 \end{pmatrix} u_1 + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} u_2$$
$$y = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$




```
function out=commande3(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
```

Guidelines

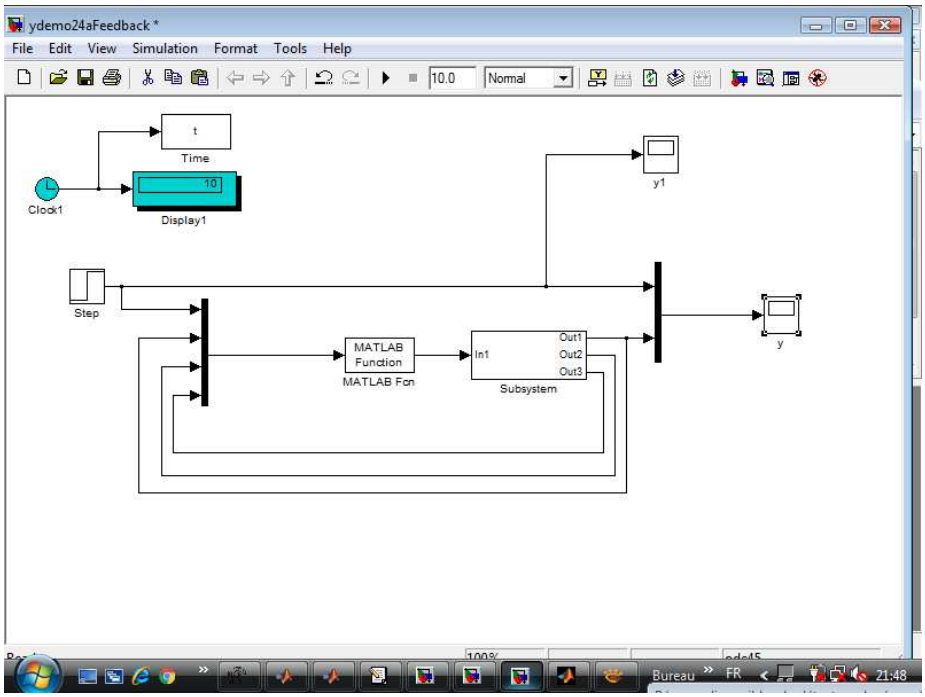


FIGURE 1 – The overall simulation model : ydemo24aFeedback.mdl

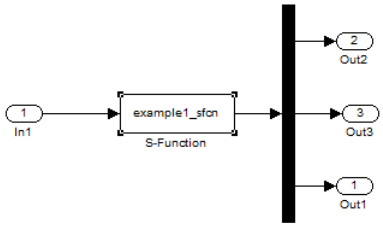


FIGURE 2 – The subsystem content with one input port and three output ports

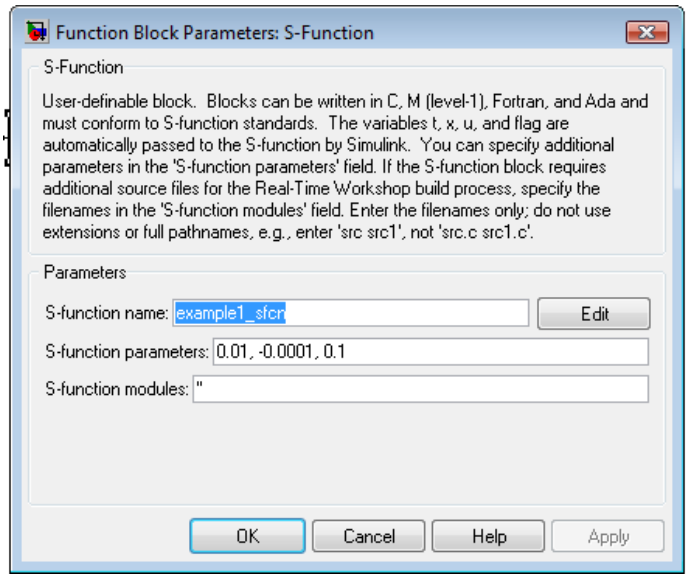


FIGURE 3 – The s-function block

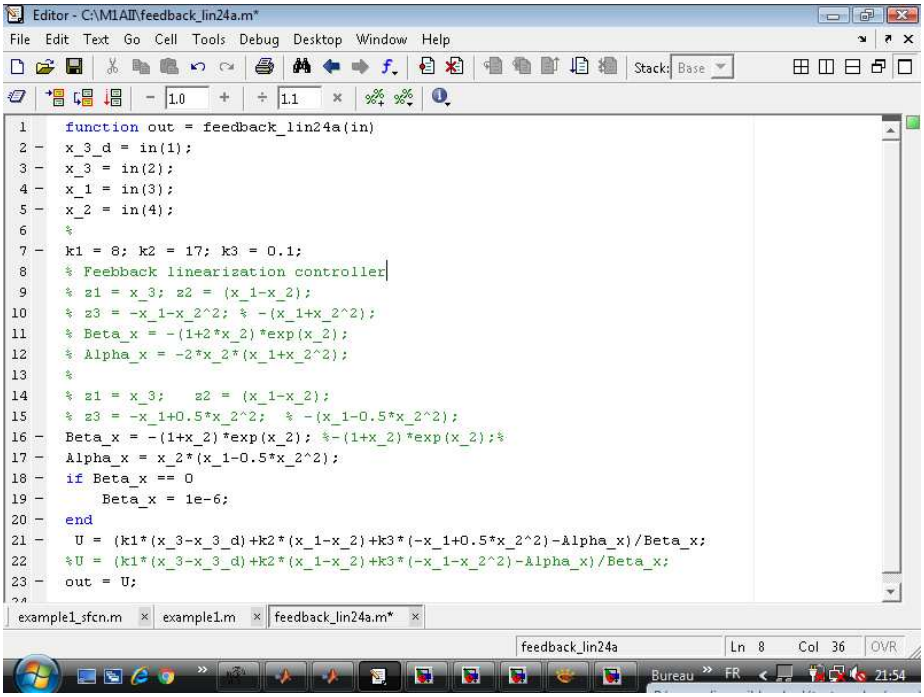


FIGURE 4 – The Matlab function named in our case Feedback_24lin.m

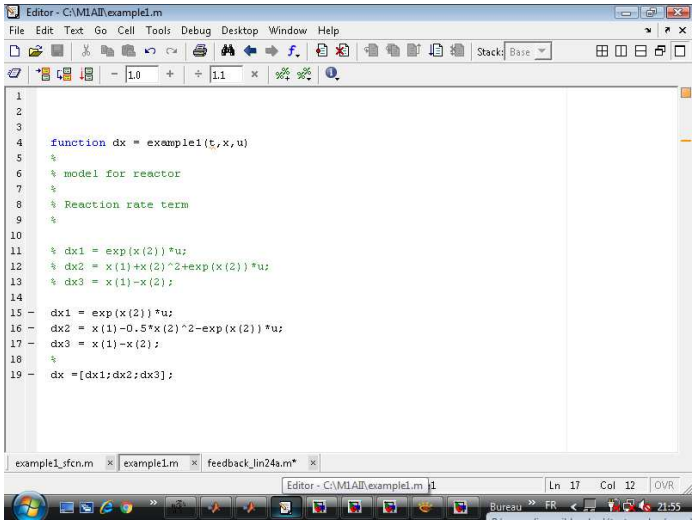


FIGURE 5 – The Matlab function named example1.m of the nonlinear model

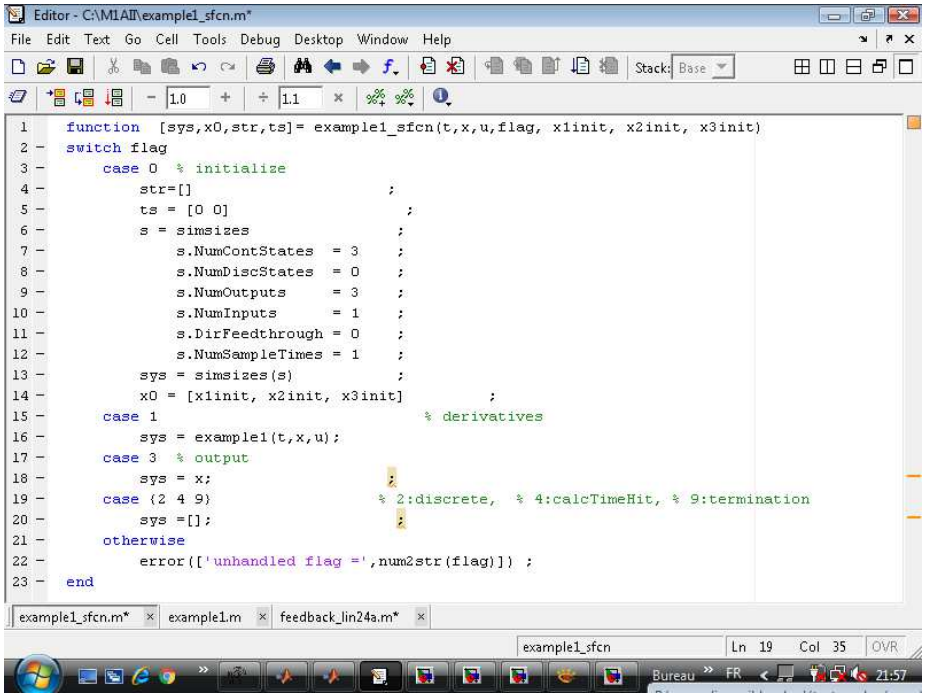


FIGURE 6 – The Matlab s-function named in our case example1_2sfcn.m

FIGURE 7 –