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Department of Electrical Engineering
Module: Nonlinear Systems
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Lab 01: Nonlinear Systems Simulation in MATLAB-SIMULINK

Objective:

Establish nonlinear systems on MATLAB-SIMULINK
Open-loop response of nonlinear systems

Exercise 01

Consider the following SISO Nonlinear System:

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

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

1. Implement this system in MATLAB-SIMULINK.
2. Provide the Open-loop system response to a unit step and to a sinusoidal signal with unit amplitude and a frequency of 0.03 Hertz.

Exercise 02

Consider the following SISO Nonlinear System:

$$\dot{x} = \begin{pmatrix} x_2 \\ -\frac{k}{I}(x_1 - x_3) - \frac{Mgl}{I}\sin(x_1) \\ x_4 \\ -\frac{k}{J}(x_1 - x_3) \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ 0 \\ \frac{1}{J} \end{pmatrix} u$$

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

1. Implement this system in MATLAB-SIMULINK.
2. Provide the Open-loop system response to a unit step.

Exercise 03

Consider the following MIMO Nonlinear System:

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

$$y = \begin{pmatrix} h_1(x) \\ h_2(x) \end{pmatrix} + \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

1. Implement this system in MATLAB-SIMULINK.
2. Provide the Open-loop system response to a unit step and to a sinusoidal signal with unit amplitude ($u_1 = u_2 = 1$) and a frequency of 0.03 Hertz.