Practice 10

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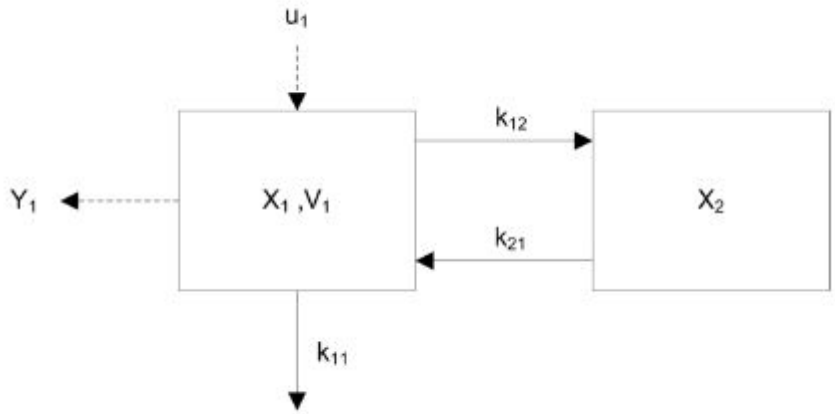
- **Block diagram of the model**



- **Differential equations of the model**

$$\dot{X}_1 = u_1 + k_{21} \cdot X_2 - X_1 \cdot (k_{12} + k_{11})$$

$$\dot{X}_2 = k_{12} \cdot X_1 - K_{21} \cdot X_2$$

$$Y_1 = \frac{X_1}{V_1}$$

- **Matrix A,B,C**

$$A = \begin{bmatrix} -k_{12} - k_{11} & k_{21} \\ k_{12} & -k_{21} \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \quad C = \begin{bmatrix} \frac{1}{V_1} & 0 \\ 0 & 0 \end{bmatrix}$$

- **Sensitivity equation**

$$\dot{\lambda} = A \cdot \lambda + H \cdot X$$

$$\eta = C \cdot \lambda + V \cdot X$$

- **Sensitivity Matrix**

k11: $H_1 = \frac{\partial A}{\partial k_{11}} = \begin{bmatrix} -1 & 0 \\ 0 & 0 \end{bmatrix} \quad V_1 = \frac{\partial C}{\partial k_{11}} = \begin{bmatrix} 0 & 0 \end{bmatrix}$

$$\dot{\lambda}_1 = -(k_{11} + k_{12}) \cdot \lambda_1 + k_{21} \cdot \lambda_2 - x_1$$

$$\dot{\lambda}_2 = k_{12} \cdot \lambda_1 - k_{21} \cdot \lambda_2$$

$$\eta = \frac{\lambda_1}{V_1}$$

k12: $H_2 = \frac{\partial A}{\partial k_{12}} = \begin{bmatrix} -1 & 0 \\ 1 & 0 \end{bmatrix}$ $V_2 = \frac{\partial C}{\partial k_{12}} = \begin{bmatrix} 0 & 0 \end{bmatrix}$

$$\dot{\lambda}_1 = -(k_{11} + k_{12}) \cdot \lambda_1 + k_{21} \cdot \lambda_2 - x_1$$

$$\dot{\lambda}_2 = k_{12} \cdot \lambda_1 - k_{21} \cdot \lambda_2 + x_1$$

$$\eta = \frac{\lambda_1}{V_1}$$

k21: $H_3 = \frac{\partial A}{\partial k_{21}} = \begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}$ $V_3 = \begin{bmatrix} 0 & 0 \end{bmatrix}$

$$\dot{\lambda}_1 = -(k_{11} + k_{12}) \cdot \lambda_1 + k_{21} \cdot \lambda_2 + x_2$$

$$\dot{\lambda}_2 = k_{12} \cdot \lambda_1 - k_{21} \cdot \lambda_2 - x_2$$

$$\eta = \frac{\lambda_1}{V_1}$$

V1: $H_4 = \frac{\partial A}{\partial V_1} = \begin{bmatrix} 0 \end{bmatrix}$ $V_4 = \frac{\partial A}{\partial V_1} = \begin{bmatrix} -\frac{1}{V_1^2} & 0 \\ 0 & 0 \end{bmatrix}$

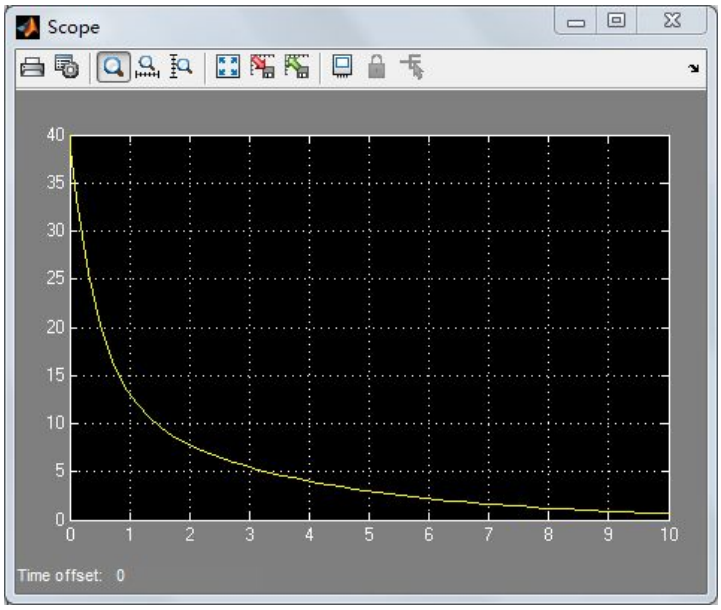
$$\dot{\lambda}_1 = -(k_{11} + k_{12}) \cdot \lambda_1 + k_{21} \cdot \lambda_2$$

$$\dot{\lambda}_2 = k_{12} \cdot \lambda_1 - k_{21} \cdot \lambda_2$$

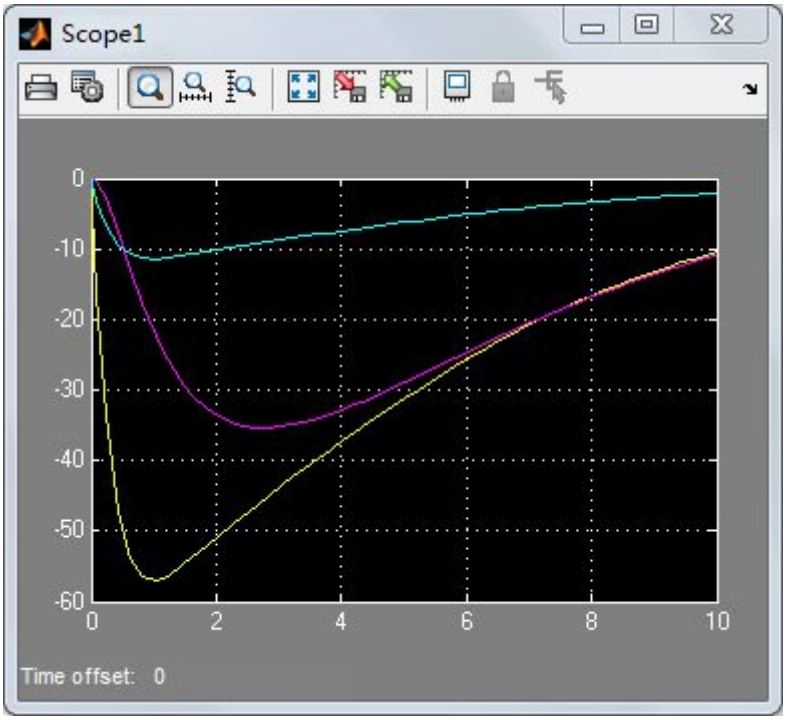
$$\eta = \frac{\lambda_1}{V_1} - \frac{x_1}{V_1^2}$$

- **Graphical output of the simulation**

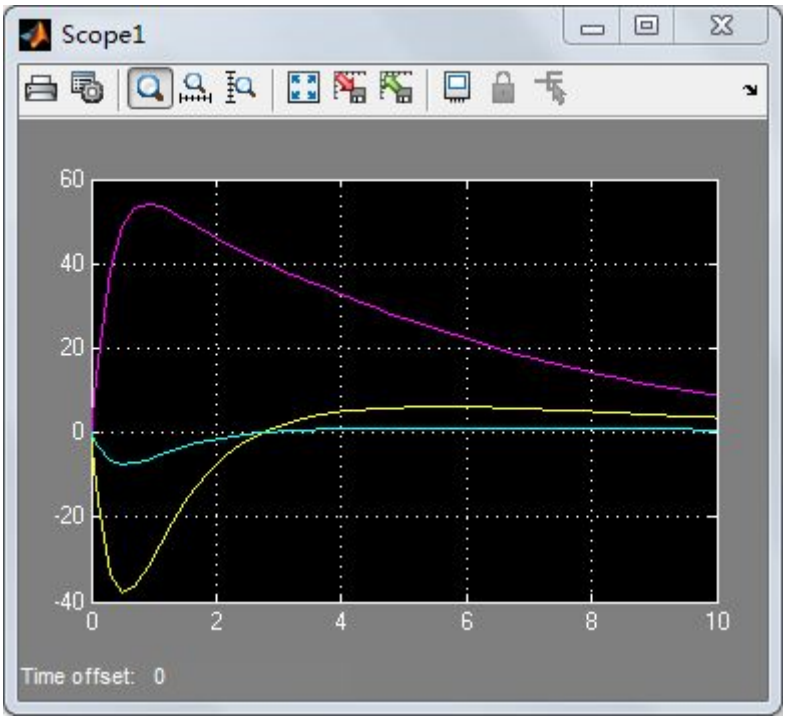
Y1:


Scope
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10
Time offset: 0

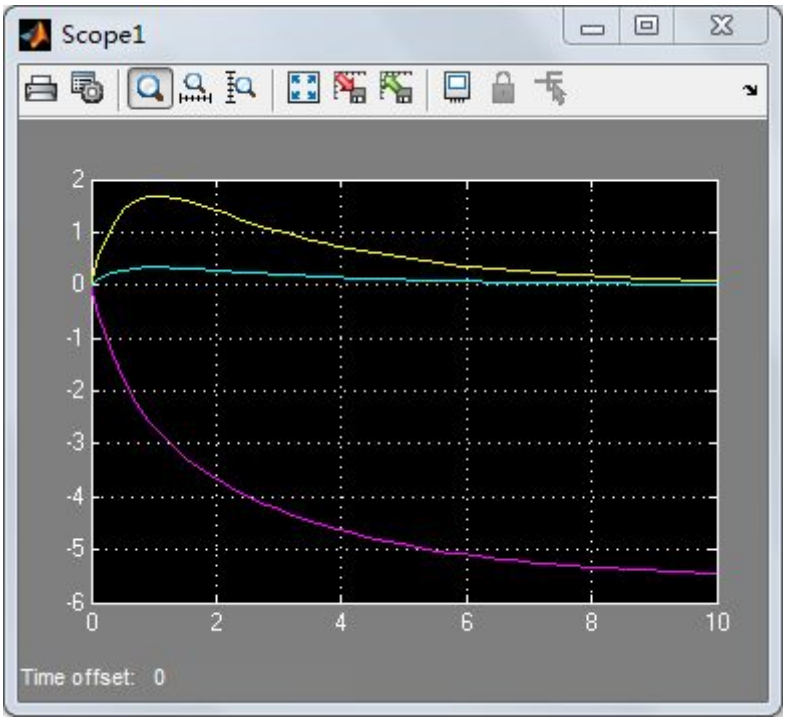
K11:


Scope1
0
-10
-20
-30
-40
-50
-60
0 2 4 6 8 10
Time offset: 0

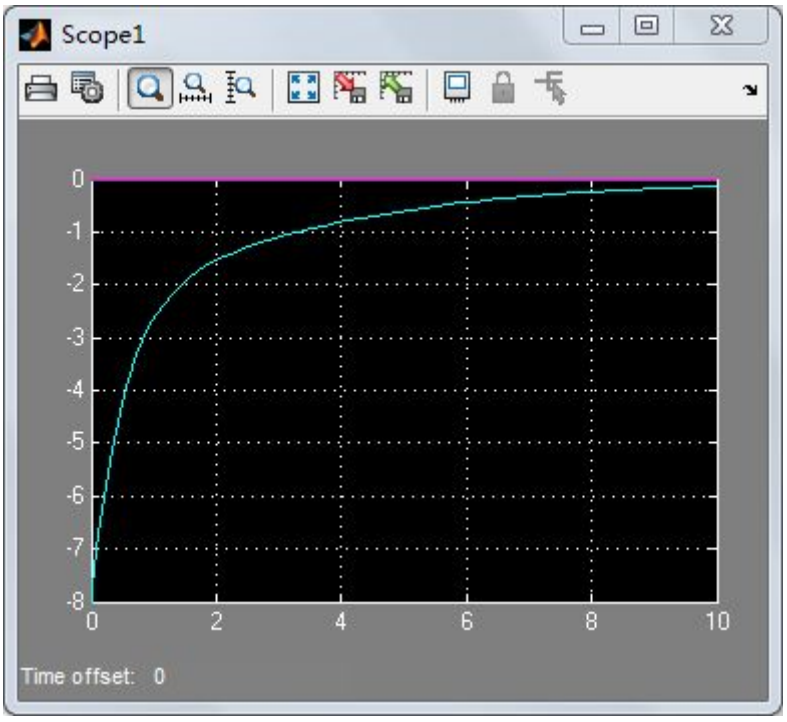
K12:


Scope1
60
40
20
0
-20
-40
0
2
4
6
8
10
Time offset: 0

K21:


Scope1
2
1
0
-1
-2
-3
-4
-5
-6
0
2
4
6
8
10
Time offset: 0

V1:


Scope1
0
-1
-2
-3
-4
-5
-6
-7
-8
0
2
4
6
8
10
Time offset: 0