

$$P = \begin{bmatrix} P_{11} & P_{12} \\ P_{12} & P_{22} \end{bmatrix}$$

$$X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$V(x) = X^T P X = \begin{bmatrix} x_1 & x_2 \end{bmatrix} \begin{matrix} 2 \times 2 \\ \begin{bmatrix} P_{11} & P_{12} \\ P_{12} & P_{22} \end{bmatrix} \end{matrix} \begin{matrix} 2 \times 2 \\ \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \end{matrix}$$

$$V(x) = \begin{bmatrix} x_1 P_{11} + x_2 P_{12} & x_1 P_{12} + x_2 P_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$V(x) = P_{11}x_1^2 + \underline{P_{12}x_1x_2} + \underline{P_{12}x_1x_2} + P_{22}x_2^2$$

$$V(x) = P_{11}x_1^2 + 2P_{12}x_1x_2 + P_{22}x_2^2$$

$$P_{11} > 0$$

$$P_{11}P_{22} - P_{12}^2 > 0$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \underbrace{\begin{bmatrix} -1 & 1 \\ -2 & -4 \end{bmatrix}}_A \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$A^T P + P A = -I$$

$$\begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix} \begin{bmatrix} P_{11} & P_{12} \\ P_{12} & P_{22} \end{bmatrix} + \begin{bmatrix} P_{11} & P_{12} \\ P_{12} & P_{22} \end{bmatrix} \begin{bmatrix} -1 & 1 \\ -2 & -4 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} -P_{11}-2P_{12} & -P_{12}-2P_{22} \\ P_{11}-4P_{12} & P_{12}-4P_{22} \end{bmatrix} + \begin{bmatrix} -P_{11}-2P_{12} & P_{11}-4P_{12} \\ -P_{12}-2P_{22} & P_{12}-4P_{22} \end{bmatrix} = -I$$

$$\begin{bmatrix} -2P_{11}-4P_{12} & P_{11}-5P_{12}-2P_{22} \\ P_{11}-5P_{12}-2P_{22} & 2P_{12}-8P_{22} \end{bmatrix} = -I = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$$

$$+2P_{11}+4P_{12} = +1$$

$$P_{11}-5P_{12}-2P_{22} = 0$$

$$2P_{12}-8P_{22} = -1$$

$$\begin{bmatrix} 2 & 4 & 0 \\ 1 & -5 & -2 \\ 0 & 2 & -8 \end{bmatrix} \begin{bmatrix} P_{11} \\ P_{12} \\ P_{22} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}$$

$$P_{11} = 13 > 0$$

$$P_{11}P_{22} - P_{12}^2 = 52 - 1 = 51 > 0$$

$$P = \frac{1}{51} \begin{bmatrix} 13 & 1 \\ 1 & 4 \end{bmatrix}$$

$$P = \frac{1}{30} \begin{bmatrix} 13 & 1 \\ 1 & 4 \end{bmatrix}$$

$$V(x) = \underline{P_{11}}x_1^2 + 2\underline{P_{12}}x_1x_2 + \underline{P_{22}}x_2^2$$

$$V(x) = \frac{1}{30} (13x_1^2 + 2x_1x_2 + 4x_2^2) > 0$$

x_1, x_2 consignos
contrario $\Rightarrow 13x_1^2 - 2x_1x_2 + 4x_2^2$

$$13x_1^2 + 4x_2^2 > 2x_1x_2$$

$$V(0) = 0$$

$$\dot{V}(x) = \frac{1}{30} (26x_1\dot{x}_1 + 2x_1\dot{x}_2 + 2x_2\dot{x}_1 + 8x_2\dot{x}_2)$$

$$\dot{x}_1 = -x_1 + x_2$$

$$\dot{x}_2 = -2x_1 - 4x_2$$

$$\frac{1}{30} (26x_1(-x_1 + x_2) + 2x_1(-2x_1 - 4x_2) + 2x_2(-x_1 + x_2) + 8x_2(-2x_1 - 4x_2))$$

$$= \frac{1}{30} (-26x_1^2 + \underline{26x_1x_2} - 4x_1^2 - \underline{8x_1x_2} - \underline{2x_1x_2} + 2x_2^2 - \underline{16x_1x_2} - 32x_2^2)$$

$$\frac{1}{30} (-30x_1^2 - 30x_2^2) = -x_1^2 - x_2^2 < 0$$

$$= -(x_1^2 + x_2^2) < 0$$

$$\dot{V}(x) = \frac{1}{3} (26x_1\dot{x}_1 + 2x_1\dot{x}_2 + 2x_2\dot{x}_1 + 8x_2\dot{x}_2)$$

$$\dot{x}_1 = -x_1 + x_2$$

$$\dot{x}_2 = -2x_1 - 4x_2 + u$$

$$U = -KX = -k_1x_1 - k_2x_2$$

$$U = x_1^2 + 5x_2$$

$$X(k+1) = A_d X(k)$$

$A_d =$

$$\begin{bmatrix} 0 & 1.0000 \\ -0.5000 & -1.0000 \end{bmatrix}$$

$P_d =$

$$\begin{bmatrix} 4.0000 & -2.0000 \\ -2.0000 & 3.0000 \end{bmatrix}$$

$$V(X(k)) = X(k)^T P X(k)$$

$$= \begin{bmatrix} x_1(k) & x_2(k) \end{bmatrix} \begin{bmatrix} 4 & -2 \\ -2 & 3 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

$$= \begin{bmatrix} 4x_1(k) - 2x_2(k), & -2x_1(k) + 3x_2(k) \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

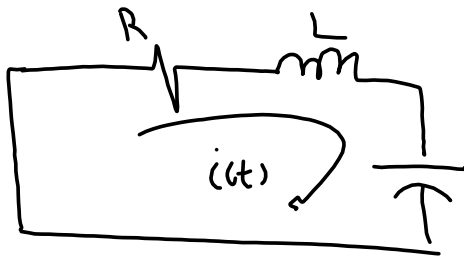
$$V(X(k)) = 4x_1^2(k) - 2x_1(k)x_2(k) - 2x_1(k)x_2(k) + 3x_2^2(k)$$

$$= 4x_1^2(k) - 4x_1(k)x_2(k) + 3x_2^2(k)$$

$$\Delta V(X(k)) = V(X(k+1)) - V(X(k))$$

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -\frac{R}{L}x_2 - \frac{1}{LC}x_1$$



$$Ri + L\frac{di}{dt} + \frac{1}{C}\int i dt = 0$$

$$R\frac{di}{dt} + L\frac{d^2i}{dt^2} + \frac{1}{C}i = 0$$

$$V(x) = \frac{1}{2}Lx_2^2 + \frac{1}{2C}x_1^2 \quad \begin{matrix} x_1 = i \\ x_2 = di/dt \end{matrix}$$

$$V(0) = 0 \checkmark$$

$$V(x) > 0 \quad \frac{1}{2}Lx_2^2 + \frac{1}{2C}x_1^2 > 0$$

$$\dot{V}(x) = Lx_2 \cdot \dot{x}_2 + \frac{1}{C}x_1 \cdot \dot{x}_1$$

$$= Lx_2 \left(-\frac{R}{L}x_2 - \frac{1}{LC}x_1 \right) + \frac{1}{C}x_1 \cdot x_2$$

$$= -Rx_2^2 - \frac{1}{C}x_1x_2 + \frac{1}{C}x_1x_2$$

$$\dot{V}(x) = -Rx_2^2 < 0$$

$$\dot{x}_1 = x_2 - x_1^3$$

$$V(x) = x_1^2 + x_2^2$$

$$\dot{x}_2 = -x_1 - x_2^3$$

$$V(x) = \frac{1}{2} (\underline{P_{11}} x_1^2 + 2 \underline{P_{12}} x_1 x_2 + \underline{P_{22}} x_2^2)$$

$$= P_{11} x_1 \dot{x}_1 + P_{12} x_1 \dot{x}_2 + P_{12} x_2 \dot{x}_1 + P_{22} x_2 \dot{x}_2$$

$$\frac{d}{dt} \left(\sum P_{12} x_1 \otimes x_2 \right) \quad \rightarrow \quad -\frac{g}{L} \sin x_1 - \frac{k}{m} x_2$$

$$= 2 P_{12} x_1 \dot{x}_2$$