

→ CONTROLABILIDADE:

$$U_c = \left[\begin{array}{cc|cc} 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 \end{array} \right] A^2 B \quad ; \quad \text{rank}(U_c) = 3$$

B AB

SIST. CONTROLÁVEL

OBSERVABILIDADE

$$V_o = \left[\begin{array}{ccc} 1 & 0 & 1 \\ 0 & 3 & -1 \\ 0 & -2 & 2 \end{array} \right] \quad ; \quad \text{rank}(V_o) = 3 \quad (\text{SIST. OBSERVÁVEL})$$

$$A^2 = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 2 & -1 \end{bmatrix} \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 2 & -1 \end{bmatrix} =$$

$$= \begin{bmatrix} 0 & 0 & 1 \\ 0 & 2 & -1 \\ 0 & -2 & 1 \end{bmatrix}$$

③ VERIFIQUE A OBSERVABILIDADE DO SISTEMA

$$\dot{x} = \begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix} x, \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

PELO MÉTODO DO GRAMIANO

$$A^T P + P A + C^* C = 0 \Rightarrow$$

$$\Rightarrow \begin{bmatrix} -1 & 0 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} a & b \\ b & c \end{bmatrix} + \begin{bmatrix} a & b \\ b & c \end{bmatrix} \begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} \begin{bmatrix} 1 & 0 \end{bmatrix} =$$

$$= \begin{bmatrix} -a & -b \\ a-b & b-c \end{bmatrix} + \begin{bmatrix} -a & a-b \\ -b & b-c \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} =$$