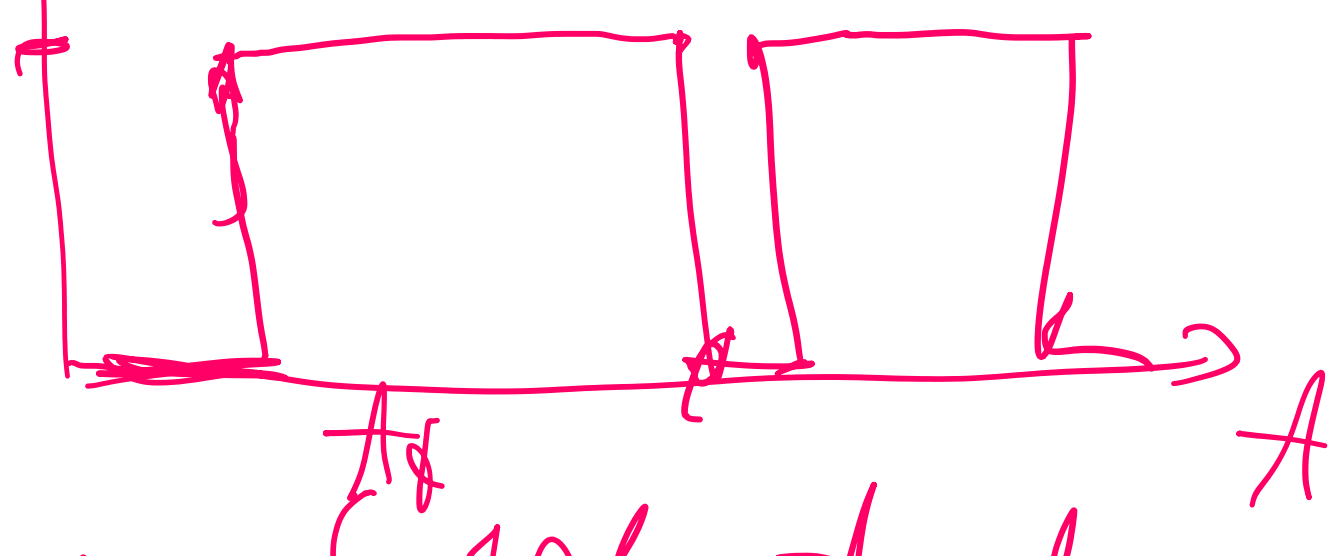


$$\begin{cases} \dot{x} = f_1(x, y, t), & x(t_0) = x_0 \\ \dot{p} = f_2(p, y, t), & p(t_f) = 0 \end{cases}$$



Bang-Bang min time



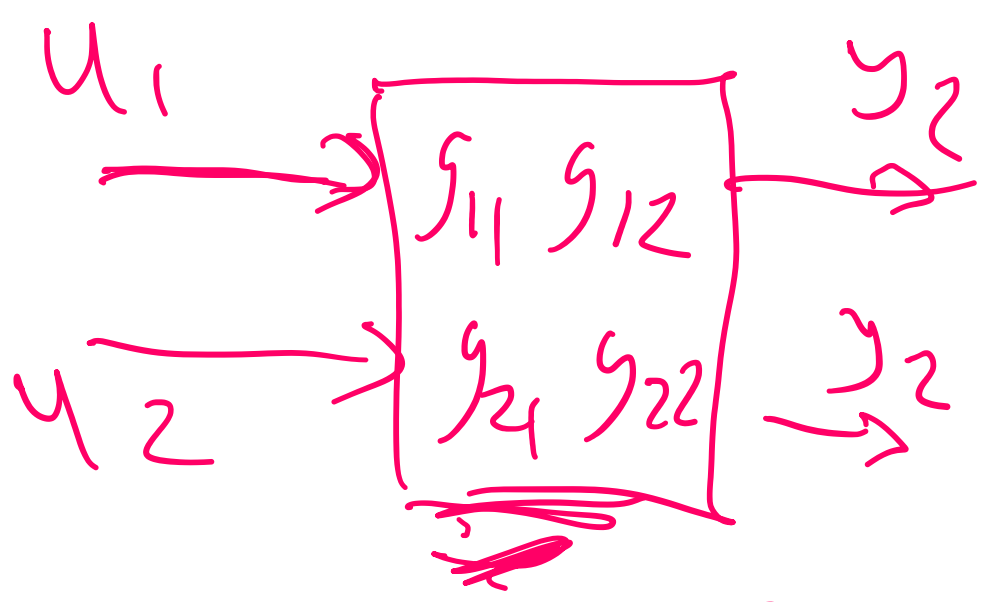
$$J = \int_{t_0}^{t_f} 1 dt = t_f - t_0$$

Bristol, 1966

$$G = \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix}, \quad RGA = G \cdot (G^{-1})^T = G \cdot (\text{pinv}(G))^T$$

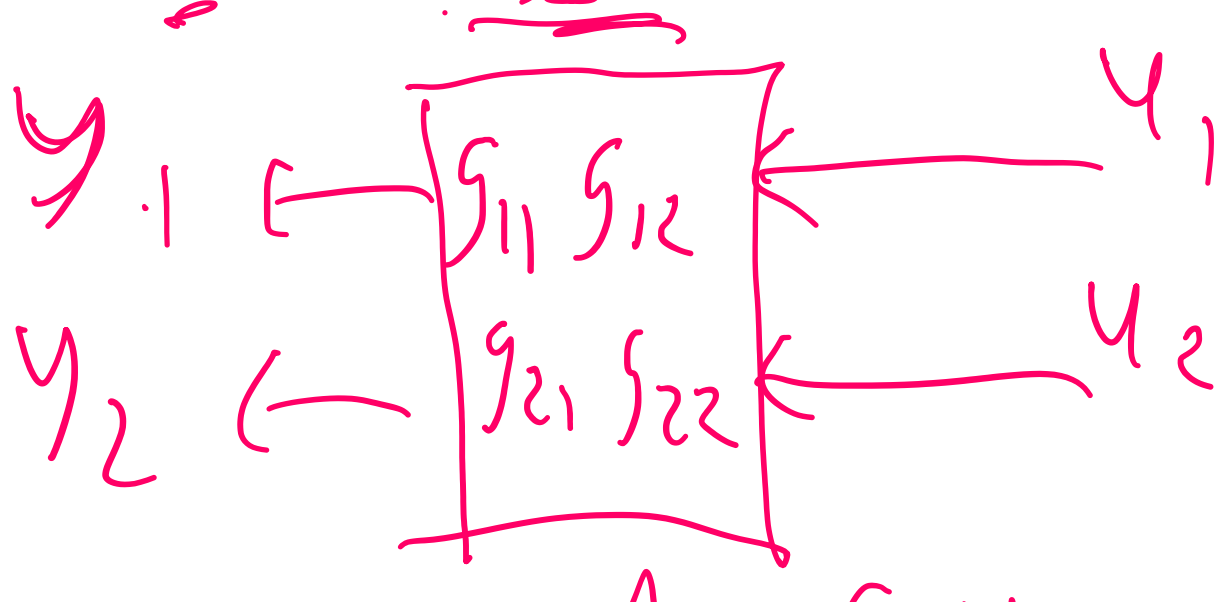
$$RGA(s) = \begin{bmatrix} 1 & 1-s \\ -s & 1 \end{bmatrix}$$

$$\Delta = \frac{1}{1 - \frac{g_{12}g_{21}}{g_{11}g_{22}}}$$



$$y_1 = g_{11}u_1 + g_{12}u_2$$

$$y_2 = g_{21}u_1 + g_{22}u_2$$



$$u_2 = 0 \Rightarrow y_1 = \underline{g_{11}}u_1$$

$$y_2 = 0 \Rightarrow u_2 = -\frac{g_{21}}{g_{22}}u_1$$

$$y_1 = g_{11}u_1 + g_{12}\left(-\frac{g_{21}}{g_{22}}u_1\right)$$

$$= \left(g_{11} - \frac{g_{12}g_{21}}{g_{22}}\right)u_1$$

$$\frac{g_{11}}{g_{11} - \frac{g_{12}g_{21}}{g_{22}}} = \frac{1}{1 - \frac{g_{21}g_{12}}{g_{11}g_{22}}} = \Delta$$

$$\text{cond}(A) = \frac{\bar{\sigma}(A)}{\underline{\sigma}(A)} = \bar{\sigma}(A)\bar{\sigma}(A^T)$$

$$W_2 \leq W_1 = W_2 U \leq U^* W_1 = \Sigma$$

$$\begin{aligned} W_2 &= U^{-1} = U^* \\ W_1 &= U \end{aligned}$$

$$W_2 \leq W_1$$

$$\begin{aligned} W_1 &= \bar{\sigma}(U) \\ W_2 &\geq I \end{aligned}$$