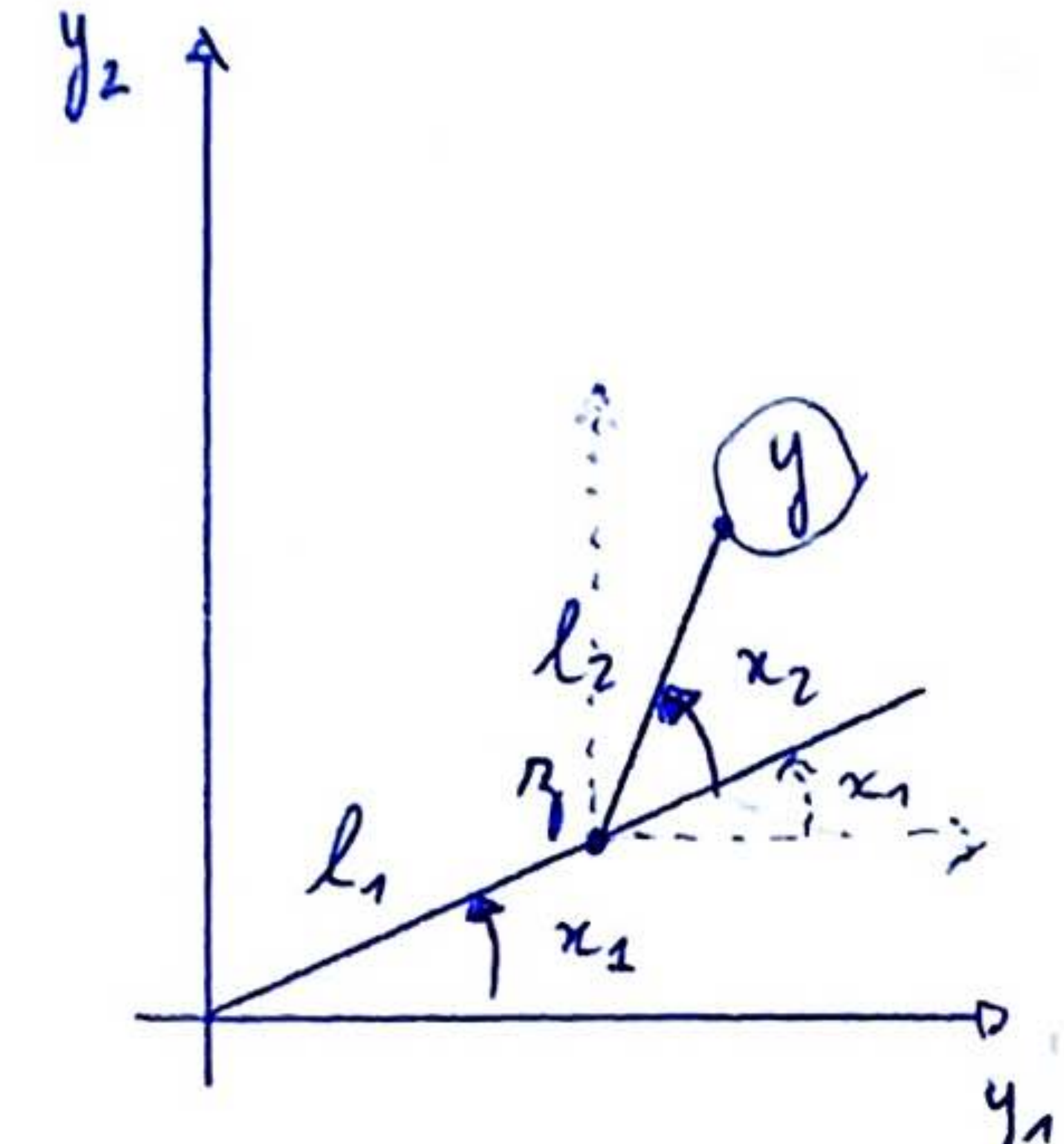
101 ROBMOOC. CRANK

(1)



équations d'état du robot :

on a $z = \begin{pmatrix} l_1 \cos x_1 \\ l_1 \sin x_1 \end{pmatrix}_{(y_1, y_2)}$

et $y = z + \begin{pmatrix} l_2 \cos(x_1 + x_2) \\ l_2 \sin(x_1 + x_2) \end{pmatrix}_{(y_1 ; y_2)}$

d'où

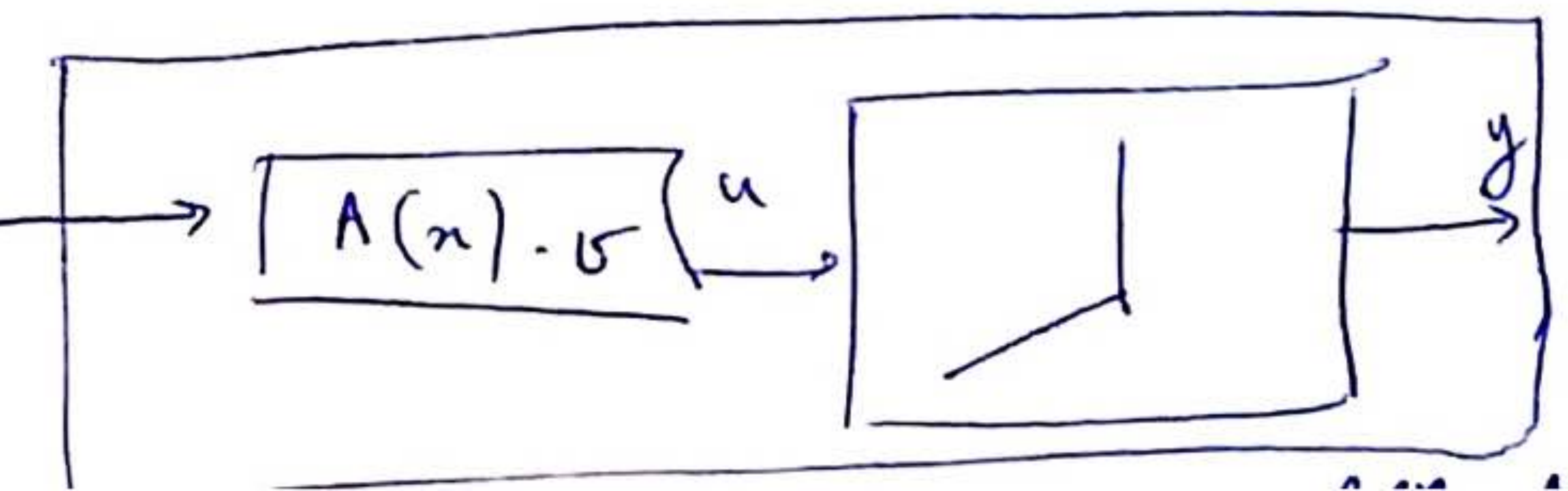
$$\boxed{\begin{cases} \begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{pmatrix} u_1 \\ u_2 \end{pmatrix} \\ y_1 = l_1 \cos x_1 + l_2 \cos(x_1 + x_2) \\ y_2 = l_1 \sin x_1 + l_2 \sin(x_1 + x_2 \end{cases}}$$

(2)

$$\dot{y} = \begin{pmatrix} -l_1 \cdot \underset{u_1}{\dot{x}_1} \cdot \sin x_1 - l_2 \cdot \sin(x_1 + x_2) \cdot (\underset{u_1}{\dot{x}_1} + \underset{u_2}{\dot{x}_2}) \\ l_1 \cdot \underset{u_1}{\dot{x}_1} \cos x_1 + l_2(\underset{u_1}{\dot{x}_1} + \underset{u_2}{\dot{x}_2}) \cdot \cos(\underset{u_1}{x_1} + \underset{u_2}{x_2}) \end{pmatrix}$$

$$= \begin{pmatrix} -l_1 \cdot \sin x_1 - l_2 \sin(x_1 + x_2) & -l_2 \sin(x_1 + x_2) \\ l_1 \cdot \cos(x_1) + l_2 \cdot \cos(x_1 + x_2) & l_2 \cos(x_1 + x_2) \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \end{pmatrix}$$

$\Rightarrow \boxed{\dot{y} = A(x) \cdot u} = v$



$$\begin{cases} \dot{y}_1 = v_1 \\ \dot{y}_2 = v_2 \end{cases}$$

on pose $\underbrace{v_1}_{\dot{y}_1} = \underbrace{g_1}_{\text{on doit le régler}} \underbrace{(w_1 - y_1)}_{e_1} + \dot{w}_1$

$\dot{y}_1 = g_1 e_1 + \dot{w}_1$

$\Rightarrow 0 = g_1 e_1 + \dot{e}_1$

$\mathcal{L} \Rightarrow 0 = \underbrace{(g_1 e_1) + s e_1}_{P(s)}$ (domaine de Laplace).

on veut les pôles en -1 d'après énoncé !

$\hookrightarrow e^{-t}$

d'où $(s + g_1) = s + 1 \Rightarrow \boxed{g_1 = 1}$

donc on a $v = \begin{pmatrix} v_1 \\ v_2 \end{pmatrix} = w - y + \dot{w}$

$$w = c + r \begin{pmatrix} \cos t \\ \sin t \end{pmatrix}$$

$$\dot{w} = r \cdot \begin{pmatrix} -\sin t \\ \cos t \end{pmatrix}$$

loi de commande : $u = A^{-1}(x) \cdot v$

(3) $\det A = \det \begin{pmatrix} \sin x_1 & \sin(x_1 + x_2) \\ \cos(x_1) & \cos(x_1 + x_2) \end{pmatrix} \cdot (-l_2 l_1) = 0$

$+ l_2^2 \overbrace{\det \begin{pmatrix} +\sin(x_1 + x_2) & -\sin(x_1 + x_2) \\ \cos(x_1 + x_2) & \cos(x_1 + x_2) \end{pmatrix}}^{=0}$

$l_1 \cdot l_2 \cdot \sin x_2 = 0$

$\Rightarrow x_2 = k \cdot \pi$

avec $k \in \mathbb{Z}$.