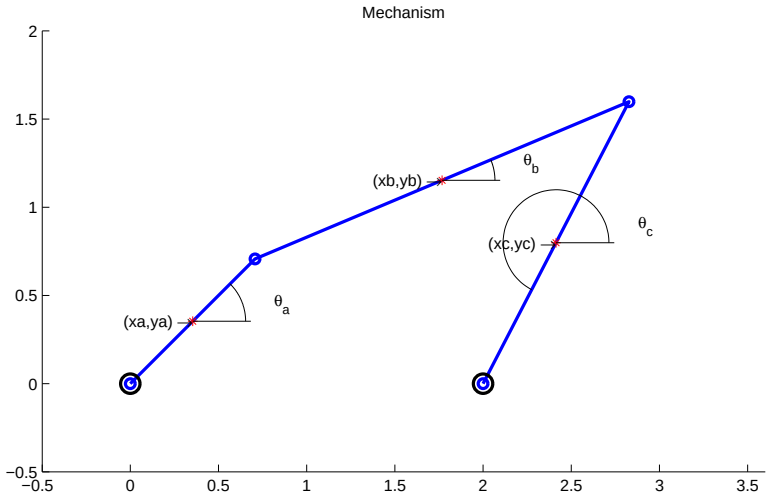
Data:

- $\theta_{a0} = 45°$
- La $= 1$
- Lb $= 2.3$
- Lc $= 1.8$
- Ld $= 2$



Generalized coordinates:

$$\mathbf{q}(t) = \left[\begin{array}{cccccccccccc} \text{xa} & \text{ya} & \text{thetaa} & \text{xb} & \text{yb} & \text{thetab} & \text{xc} & \text{yc} & \text{thetac} & \text{xd} & \text{yd} \end{array}\right]^T$$

Constraints:

$$\mathbf{\Phi}(\mathbf{q}(t), t) = \left\{\begin{array}{c} xa - \frac{L2\cos(\theta_a)}{2} \\ ya - \frac{L2\sin(\theta_a)}{2} \\ xb - xa - \frac{L2\cos(\theta_a)}{2} - \frac{L3\cos(\theta_b)}{2} \\ yb - ya - \frac{L2\sin(\theta_a)}{2} - \frac{L3\sin(\theta_b)}{2} \\ xc - xb - \frac{L3\cos(\theta_b)}{2} - \frac{L4\cos(\theta_c)}{2} \\ yc - yb - \frac{L3\sin(\theta_b)}{2} - \frac{L4\sin(\theta_c)}{2} \\ L1 - xc - \frac{L4\cos(\theta_c)}{2} \\ -yc - \frac{L4\sin(\theta_c)}{2} \\ \text{xd} - \text{xa} - \frac{\text{L5}\cos(\beta + \theta_\text{b})}{2} - \frac{\text{L2}\cos(\theta_\text{a})}{2} \\ \text{yd} - \text{ya} - \frac{\text{L5}\sin(\beta + \theta_\text{b})}{2} - \frac{\text{L2}\sin(\theta_\text{a})}{2} \\ \theta_a - \theta_{a0} - t\,w \end{array}\right\}$$

Velocities:

$$\mathbf{\Phi_q} = \begin{pmatrix} 1 & 0 & \frac{\mathrm{L2}\,\sin(\theta_\mathrm{a})}{2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & -\frac{\mathrm{L2}\,\cos(\theta_\mathrm{a})}{2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & \frac{\mathrm{L2}\,\sin(\theta_\mathrm{a})}{2} & 1 & 0 & \frac{\mathrm{L3}\,\sin(\theta_\mathrm{b})}{2} & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & -\frac{\mathrm{L2}\,\cos(\theta_\mathrm{a})}{2} & 0 & 1 & -\frac{\mathrm{L3}\,\cos(\theta_\mathrm{b})}{2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & \frac{\mathrm{L3}\,\sin(\theta_\mathrm{b})}{2} & 1 & 0 & \frac{\mathrm{L4}\,\sin(\theta_\mathrm{c})}{2} & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & -\frac{\mathrm{L3}\,\cos(\theta_\mathrm{b})}{2} & 0 & 1 & -\frac{\mathrm{L4}\,\cos(\theta_\mathrm{c})}{2} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & \frac{\mathrm{L4}\,\sin(\theta_\mathrm{c})}{2} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & -\frac{\mathrm{L4}\,\cos(\theta_\mathrm{c})}{2} & 0 & 0 \\ -1 & 0 & \frac{\mathrm{L2}\,\sin(\theta_\mathrm{a})}{2} & 0 & 0 & \frac{\mathrm{L5}\,\sin(\beta+\theta_\mathrm{b})}{2} & 0 & 0 & 0 & 1 & 0 \\ 0 & -1 & -\frac{\mathrm{L2}\,\cos(\theta_\mathrm{a})}{2} & 0 & 0 & -\frac{\mathrm{L5}\,\cos(\beta+\theta_\mathrm{b})}{2} & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\mathbf{\Phi_t} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ -w \end{pmatrix}$$

Accelerations:

$$\gamma = \begin{pmatrix} -\frac{\mathrm{L2}\,\dot{\theta}_{\mathrm{a}}^2\,\cos(\theta_{\mathrm{a}})}{2} \\ -\frac{\mathrm{L2}\,\dot{\theta}_{\mathrm{a}}^2\,\sin(\theta_{\mathrm{a}})}{2} \\ -\frac{\mathrm{L2}\,\cos(\theta_{\mathrm{a}})\,\dot{\theta}_{\mathrm{a}}^2}{2} - \frac{\mathrm{L3}\,\cos(\theta_{\mathrm{b}})\,\dot{\theta}_{\mathrm{b}}^2}{2} \\ -\frac{\mathrm{L2}\,\sin(\theta_{\mathrm{a}})\,\dot{\theta}_{\mathrm{a}}^2}{2} - \frac{\mathrm{L3}\,\sin(\theta_{\mathrm{b}})\,\dot{\theta}_{\mathrm{b}}^2}{2} \\ -\frac{\mathrm{L3}\,\cos(\theta_{\mathrm{b}})\,\dot{\theta}_{\mathrm{b}}^2}{2} - \frac{\mathrm{L4}\,\cos(\theta_{\mathrm{c}})\,\dot{\theta}_{\mathrm{c}}^2}{2} \\ -\frac{\mathrm{L3}\,\sin(\theta_{\mathrm{b}})\,\dot{\theta}_{\mathrm{b}}^2}{2} - \frac{\mathrm{L4}\,\sin(\theta_{\mathrm{c}})\,\dot{\theta}_{\mathrm{c}}^2}{2} \\ -\frac{\mathrm{L4}\,\dot{\theta}_{\mathrm{c}}^2\,\cos(\theta_{\mathrm{c}})}{2} \\ -\frac{\mathrm{L4}\,\dot{\theta}_{\mathrm{c}}^2\,\sin(\theta_{\mathrm{c}})}{2} \\ -\frac{\mathrm{L2}\,\cos(\theta_{\mathrm{a}})\,\dot{\theta}_{\mathrm{a}}^2}{2} - \frac{\mathrm{L5}\,\cos(\beta+\theta_{\mathrm{b}})\,\dot{\theta}_{\mathrm{b}}^2}{2} \\ -\frac{\mathrm{L2}\,\sin(\theta_{\mathrm{a}})\,\dot{\theta}_{\mathrm{a}}^2}{2} - \frac{\mathrm{L5}\,\sin(\beta+\theta_{\mathrm{b}})\,\dot{\theta}_{\mathrm{b}}^2}{2} \\ 0 \end{pmatrix}$$