PROBLEMA

$$\begin{cases} M(q)\ddot{q} = f(q,\dot{q},t) \\ 0 = \Phi(q) \\ q = \bar{q}_0,\ \bar{q}_1 \end{cases}$$

(1)
$$\begin{cases} \dot{q} = v \\ M(q)\dot{v} = f(q,\dot{q},t) \\ \frac{\partial \Phi}{\partial q}\dot{v} + 2\zeta\omega_n \frac{d}{dt}\frac{\partial \Phi}{\partial q} v + \omega_n^2 \Phi = 0 \end{cases}$$

BAUMGARTE

(2)
$$\begin{cases} \dot{q} = v \\ M(q)\dot{v} = f(q,\dot{q},t) \\ \frac{d}{dt}\frac{\partial \Phi}{\partial q} v + \frac{\partial \Phi}{\partial q}\dot{v} = 0 \end{cases}$$

INDEX REDUCTION

(3)
a) $\Phi = 0$

b) $\frac{d}{dt}\Phi = 0 \rightarrow \left(\frac{\partial \Phi}{\partial q} v\right) = 0$

$$\int 1 + \frac{1}{2}\Phi^T\Phi + \frac{1}{2}\left(\frac{\partial \Phi}{\partial q} v\right)^T \left(\frac{\partial \Phi}{\partial q} v\right) w_2$$

PENALISE CONSTRAINT & ~~SPEED~~