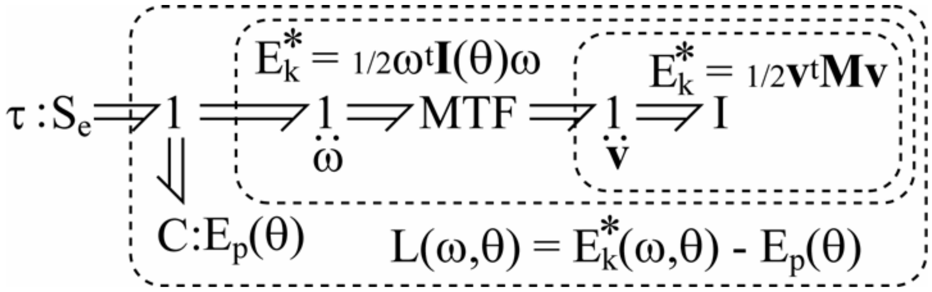
# LAGRANGE'S EQUATIONS (CONTINUED)




Mechanism in "uncoupled" inertial coordinates:
(innermost box in the figure)

$$\mathbf{F} = d\mathbf{p}/dt\,;\ \mathbf{p} = \mathbf{M}\mathbf{v}$$

Mechanism in generalized coordinates:
(middle box in the figure)

$$\tau = d\eta/dt - \partial Ek^*/\partial\theta;\ \eta = \mathbf{I}(\theta)\omega;\ Ek^*(\theta,\omega) = \tfrac{1}{2}\omega^t\mathbf{I}(\theta)\omega$$

or

$$\frac{d}{dt}\left[\frac{\partial L}{\partial \boldsymbol{\omega}}\right] - \frac{\partial L}{\partial \boldsymbol{\theta}} = \tau \quad \text{with} \quad L(\theta,\omega) = Ek^*(\theta,\omega)$$

Add elastic elements in generalized coordinates:
(outermost box in the figure)

$$\boldsymbol{\tau} = \boldsymbol{\tau}_{inertial} + \boldsymbol{\tau}_{elastic} = d\boldsymbol{\eta}/dt - \partial E_k^*/\partial\boldsymbol{\theta} + \partial E_p/\partial\boldsymbol{\theta}$$

or

$$\frac{d}{dt}\left[\frac{\partial L}{\partial \boldsymbol{\omega}}\right] - \frac{\partial L}{\partial \boldsymbol{\theta}} = \boldsymbol{\tau} \quad \text{with} \quad L(\theta,\omega) = E_k^*(\theta,\omega) - E_p(\theta)$$