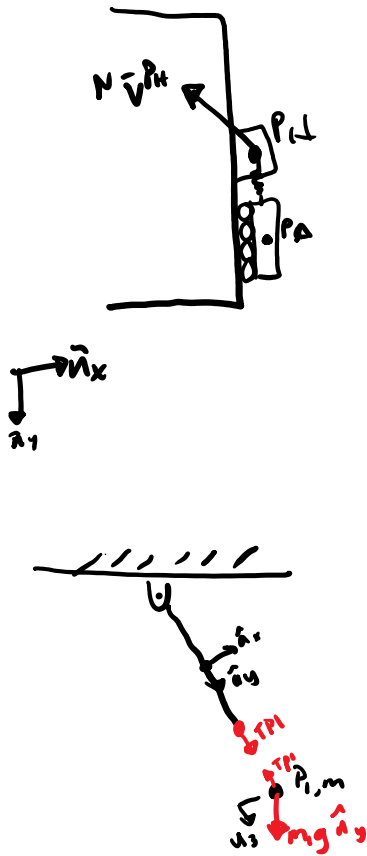


- Final report due Thursday 12th midnight
- 5 minute lightning talk Thursday 12th 1-3pm
↳ strict!
- Fill out course evals. eval.ucdavis.edu
- Exam due Friday midnight



Linearization of EoM

Dynamical

$$0 = \mathcal{F}(\bar{q}, \bar{u}, \dot{\bar{u}}, t) \Rightarrow M\ddot{\bar{u}} = \hat{\mathcal{F}}(\bar{q}, \bar{u}, t) \Rightarrow \ddot{\bar{u}} = M^{-1} \hat{\mathcal{F}}$$

kinematical

$$0 = \mathcal{G}(\bar{q}, \dot{\bar{q}}, \bar{u}, t) \Rightarrow Y\dot{\bar{q}} = \hat{\mathcal{G}}(\bar{q}, \bar{u}, t) \Rightarrow \dot{\bar{q}} = Y^{-1} \hat{\mathcal{G}}$$

implicit explicit

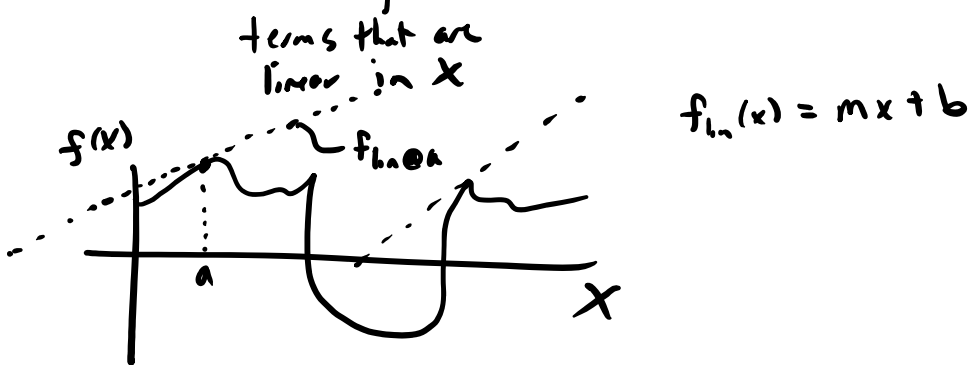
$$\begin{aligned} \ddot{\bar{u}} &= \hat{\mathcal{F}}(\bar{q}, \bar{u}, t) \\ \dot{\bar{q}} &= \hat{\mathcal{G}}(\bar{q}, \bar{u}, t) \end{aligned}$$

$$\bar{X} = \begin{bmatrix} \bar{u} \\ \bar{q} \end{bmatrix} \quad \dot{\bar{X}} = \begin{bmatrix} \hat{\mathcal{F}} \\ \hat{\mathcal{G}} \end{bmatrix}$$

↑
state vector

Recall a Taylor Series expansion about $x=a$.

$$f(x) = \underbrace{f(a) + \frac{f'(a)}{1!}(x-a)}_{\text{terms that are linear in } x} + \frac{f''(a)}{2!}(x-a)^2 + \frac{f'''(a)}{3!}(x-a)^3 + \dots$$



$$\bar{X}_{eq} = \begin{bmatrix} \bar{u}_{eq} \\ \bar{q}_{eq} \end{bmatrix} \quad \bar{h} = \begin{bmatrix} \hat{\mathcal{F}} \\ \hat{\mathcal{G}} \end{bmatrix} = \begin{bmatrix} \mathcal{F}(\bar{q}, \bar{u}, \dot{\bar{u}}, t) \\ \mathcal{G}(\bar{q}, \dot{\bar{q}}, \bar{u}, t) \end{bmatrix}$$

↑
equilibrium point of mech. system

$$\bar{h} \Big|_{\substack{\ddot{\bar{u}}=0 \\ \dot{\bar{u}}=0 \\ \dot{\bar{q}}=0}} \Rightarrow \text{solve for any equilibrium states.}$$

$$0 = \bar{h}(\bar{q}, \dot{\bar{q}}, \bar{u}, \dot{\bar{u}}, t) \Rightarrow 0 = \bar{h}(\bar{X}, \dot{\bar{X}}, t)$$

$$\bar{h}_{lin} = \bar{h}(\bar{X}_{eq}) + J_{\bar{h}}(\bar{X}_{eq}) \cdot (\bar{X} - \bar{X}_{eq}) \quad \rightarrow \text{for holonomic}$$

...

$J_h \triangleq$ Jacobian of \bar{h} wrt \bar{x}

$$J_h = \left[\frac{\partial \bar{h}}{\partial x_1}, \frac{\partial \bar{h}}{\partial x_2}, \dots, \frac{\partial \bar{h}}{\partial x_n}, \frac{\partial \bar{h}}{\partial u_1}, \dots, \frac{\partial \bar{h}}{\partial u_n} \right]$$