ECE 447: Control Systems (Fall 2020)

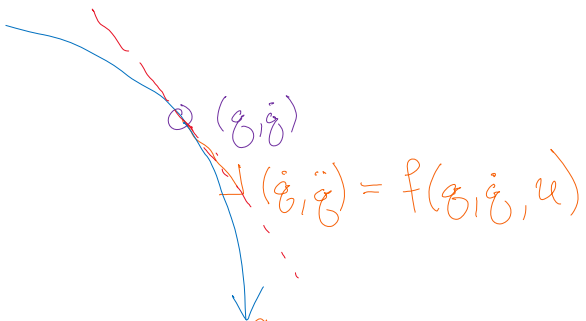
Prof: Sam Burden TA: Haonan Peng

* if/when possible: keep video on; unmute to ask questions
* update your preferred name at identity.uw.edu

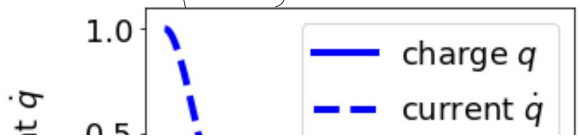
today:
- ☑ HW1 assigned – due Fri Oct 16 → add pdf
- ☑ week 2 lectures posted (~ 1 hr 20 min)
- ☑ office hour
  → Colaboratory notebook

TODO: ~~HW pdf~~
- ~~HW1 P2b – how to quantify?~~
- ~~lec1 ML refs~~

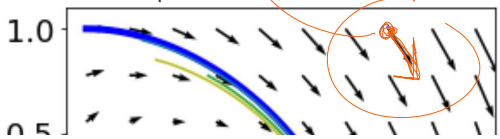
$$\ddot{q} = \frac{1}{L}\left(\cancel{u}^{\,0} - R\cancel{\dot{q}}^{\,0} - \frac{1}{C}q\right) = \frac{-1}{LC}q$$

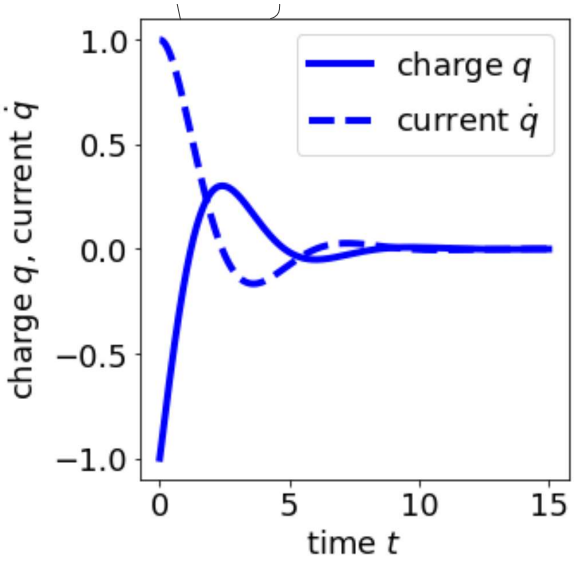


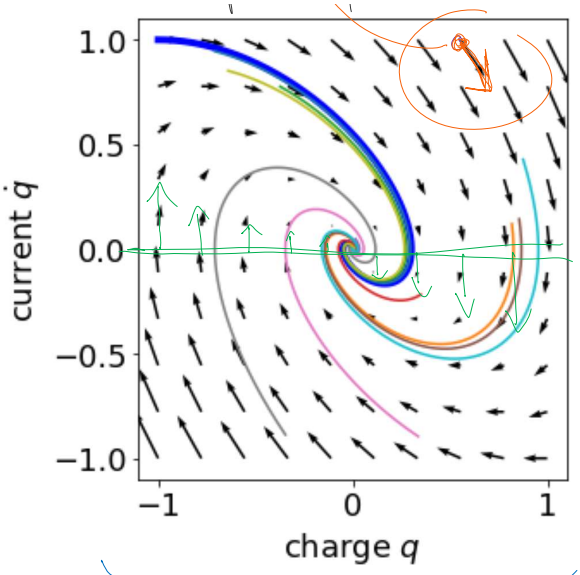
1°. one trajectory over time



2°. multiple trajectories over time







state space $= \left\{ \begin{bmatrix} q \\ \dot{q} \end{bmatrix} \in \mathbb{R}^2 \right\}$

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what is a nonlinear system?

$\dot{x} = f(x,u)$ is a linear system if

I can find A, B s.t. $\dot{x} = f(x,u) = Ax + Bu$

$(x \in \mathbb{R}^n,\ u \in \mathbb{R}^p \Rightarrow A \in \mathbb{R}^{n \times n},\ B \in \mathbb{R}^{n \times p})$

ex: nonlinear system: $x = (q, \dot{q})$

$$\dot{x} = \begin{bmatrix} \dot{q} \\ \ddot{q} \end{bmatrix} = \begin{bmatrix} \dot{q} \\ g/\ell \sin q - \frac{\alpha}{m\ell^2}\dot{q} + \frac{1}{m\ell} u \cos q \end{bmatrix}$$

$$\begin{bmatrix} \dot{\theta} \\ \ddot{\theta} \end{bmatrix} = f(x,u) = \underbrace{\begin{bmatrix} 0 & 1 \\ 0 & -\frac{\alpha}{ml^2} \end{bmatrix}}_{A} \begin{bmatrix} \theta \\ \dot{\theta} \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \\ 0 \end{bmatrix}}_{B} u + \underbrace{\begin{bmatrix} 0 \\ \frac{g}{l}\sin\theta + \frac{u\cos\theta}{ml} \end{bmatrix}}_{\text{not linear}}$$

$$\simeq \begin{bmatrix} 0 & 1 \\ g/l & -\frac{\alpha}{ml^2} \end{bmatrix} \begin{bmatrix} \theta \\ \dot{\theta} \end{bmatrix} + \begin{bmatrix} 0 \\ 1/ml \end{bmatrix} u + O(\theta^2 + \dot{\theta}^2)$$