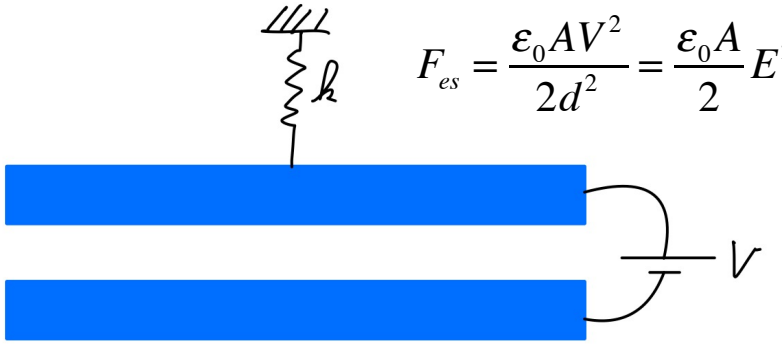
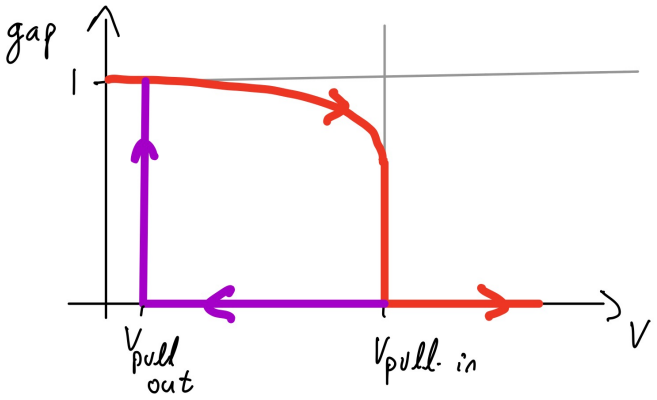
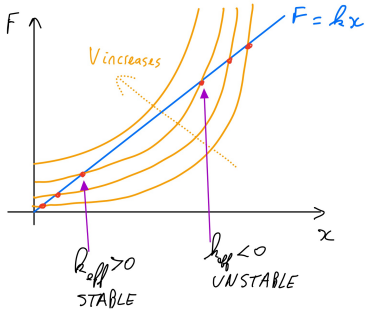
ES actuators
Parallel plate vs. Comb drive

$$F_{es} = \frac{\varepsilon_0 A V^2}{2d^2} = \frac{\varepsilon_0 A}{2} E^2$$

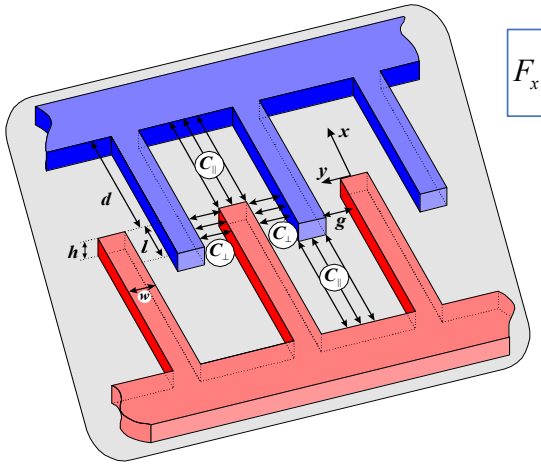




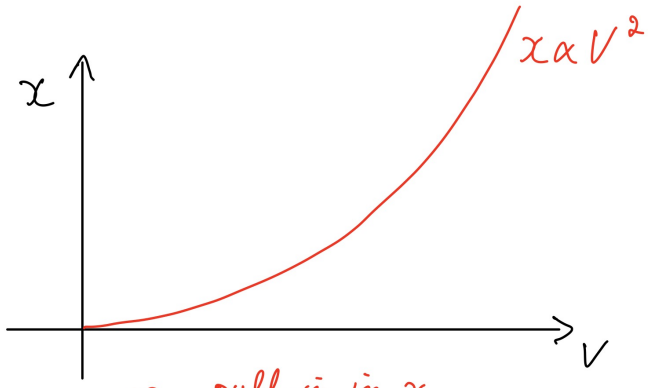


- Max 1/3 gap controlled motion
- Spring softening

Good or bad? When is this helpful?



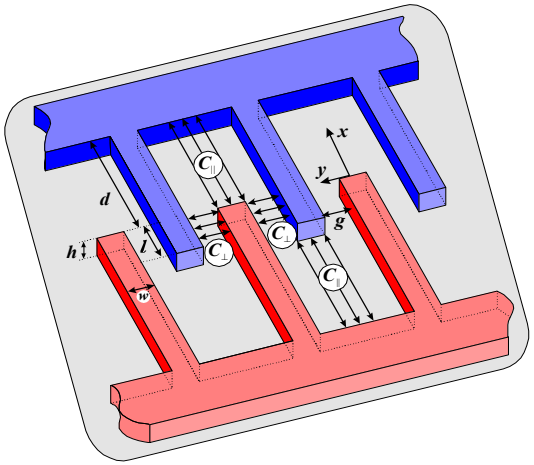
$$F_x = \frac{1}{2}\frac{dC}{dx}V^2 = N \cdot \frac{\varepsilon_0 h}{g}V^2$$



no pull-in in x
but pull-in in y

Actuator sizing for 1 mN force at 100 v

- Comb drive actuator:
  - How big should initial overlap be?
  - What h/g can we realistically get?
  - Design a comb-drive to get 1mN force:
    - how much area do you need? (assume 100 µm stroke)



$$F_x = \frac{1}{2}\frac{dC}{dx}V^2 = N \cdot \frac{\varepsilon_0 h}{g}V^2$$

- Parallel plate actuator
  - Design to get 1 mN force.
  - How much area do you need? Compute for gap d= 30 µm, 100 µm, 300 µm.