Lecture 18: Equivalent Circuits I

- Announcements:
- HW#5 online for a while; due Tuesday, 4/9
- Module 11 on Equivalent Circuits I online
- Module 12 on Capacitive Transducers online
- Will pass back graded Midterm Exam w/ solutions
  - Will got through grading policy
  - Will show Z-scores
- Project Definition online (and will discuss today)
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- Reading: Senturia, Chpt. 5
- Lecture Topics:
  - Lumped Mechanical Equivalent Circuits
  - Electromechanical Analogies
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- Reading: Senturia, Chpt. 5, Chpt. 6
- Lecture Topics:
  - Energy Conserving Transducers
    - Charge Control
    - Voltage Control
  - Parallel-Plate Capacitive Transducers
    - Linearizing Capacitive Actuators
    - Electrical Stiffness
  - Electrostatic Comb-Drive
    - 1st Order Analysis
    - 2nd Order Analysis
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- Last Time:
- Determined resonance frequency of a distributed micromechanical structure

and

$$\boxed{K_{max} = X_o^2 \omega_o^2 \left[\frac{1}{2}M_s + \frac{1}{8}M_t + \frac{6}{35}M_b\right]}$$

for the total mechanical ckt.

both trusses — all beams

W_{max} → max. potential energy → equal to the work done to achieve maximum deflection

$$W_{max} = \frac{1}{2}k_x X_o^2$$

Then, using Rayleigh-Ritz:

$$K_{max} = W_{max}$$

$$\cancel{X_o^2}\,\omega_o^2\left[\frac{1}{2}M_s + \frac{1}{8}M_t + \frac{6}{35}M_b\right] = \frac{1}{2}\overset{k_c}{\cancel{k_x}}\,\cancel{X_o^2}$$

$$\boxed{\omega_o = \left[\frac{k_c}{M_{eq}}\right]^{1/2} \quad \text{where } M_{eq} = M_s + \frac{1}{4}M_t + \frac{12}{35}M_b}$$

(Resonance Freq. of a Folded-Beam Suspended Shuttle)

- The rest of the lecture done via Module 11, since I did not have my surface pen this day
- It still worked out well