

Lecture 3: Benefits of Scaling II

- Announcements:
- Make-up lecture:
 - ↳ Friday afternoon, 1/31, 3 p.m.
- Still figuring out how to get lecture videos online
 - ↳ Either ETS (YouTube) or our website
- HW#1 online

 • Today:

- Reading: Senturia, Chapter 1
- Lecture Topics:

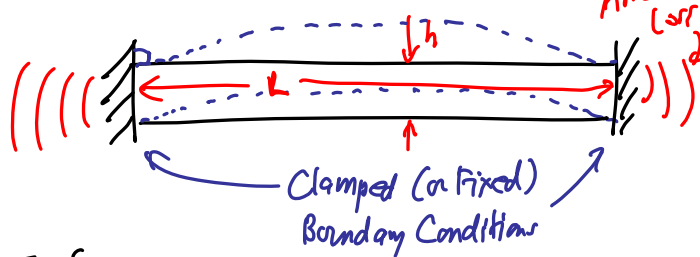
↳ Benefits of Miniaturization

↳ Examples

- GHz micromechanical resonators
- Chip-scale atomic clock
- Thermal Circuits

$$Q = \frac{\text{Energy Per Cycle}}{\text{Energy Lost Per Cycle}}$$

 • Last Time: Going through module 2

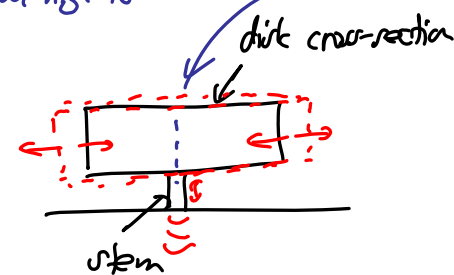
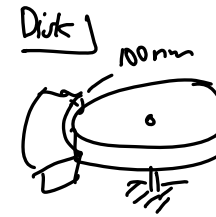
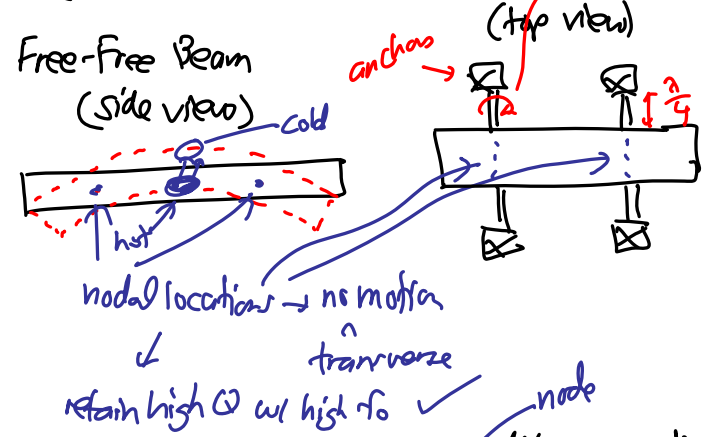


⇒ Eq. for resonance:

$$f_0 = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = 1.03 \sqrt{\frac{E}{\rho}} \frac{h}{L^2} \rightarrow L \downarrow \rightarrow f_0 \uparrow \uparrow \quad (1)$$

where $E \triangleq$ Young's modulus [GPa] $h \triangleq$ thickness [m]
 $\rho \triangleq$ density [kg/m^3] $L \triangleq$ length [m]

⑤ Better Soln. other geometries



Circuit Design

Transistor Electr.

