Logistics

• Discussion will remain Wednesdays 12 – 1pm
• I will be out the next two weeks – back on Feb. 16th
• Will be available via Piazza, email, Skype (if need be), etc.
• OH & discussion will still be held
  – Led by Alper Ozgurluk
Thermal/Electrical Hybrid Circuits

- The circuit problems we’ve looked at have been mostly thermal
- Inputs have been convenient power sources (like lasers)
- Is this actually useful? How is thermal energy typically coupled into a thermal body/MEMS?

Electrical power through resistive heating!
Power Dissipated in a Resistor

- Remember Ohm’s law!

$$V = I \cdot R, \quad I = \frac{V}{R}$$

$$P = I \cdot V$$

$$P = \frac{V^2}{R} = I^2R$$

Most of this energy is thermal!
Reminder: Electrical Resistance

\[ R = \frac{l}{\sigma \cdot A} \]

- resistance (\(\Omega\))
- length (\(m\))
- conductivity (\((\Omega \cdot m)^{-1}\))
- cross-sectional area (\(m^2\))
How do we handle circuits with multiple inputs (i.e., sources)?

1. Pick a source to analyze
2. Suppress (turn off) all other inputs
   - Set either V or I to zero
   - This means short-circuiting voltage sources & open-circuiting current sources
3. Find the output of interest for the modified circuit
4. Repeat steps 1-3 for all sources
5. Sum all resultant outputs to find total output due to all sources
Thermal Ckt. Example

- $V_A$ represents a step function voltage source (can think of it as switching the voltage on at some time, $t$)
- Find the time-constant of the circuit
- Find the steady-state temperature on the shuttle if the final value of $V_A$ is 1V