ECE 321 - Homework #2

Temperature Sensors, Audio & Strain Sensors, Calibration & Noise. Due Monday, April 11th

Please make the subject "ECE 321 HW#2" if submitting homework electronically to Jacob_Glower@yahoo.com (or on blackboard)

Temperature Sensors

Assume you are using a thermistor where the temperature - resistance relationship is

$$R = 1000\ \exp\left(\frac{3905}{T+273} - \frac{3905}{298}\right)\ \Omega$$

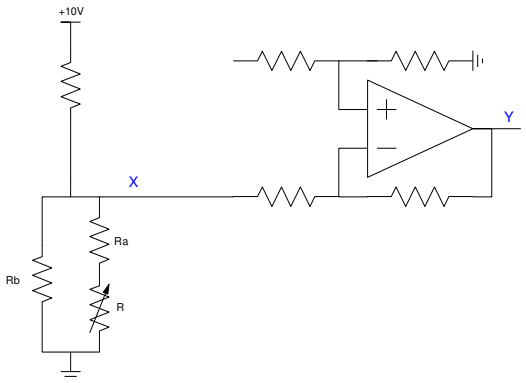
where T is the temperature in degrees C.

1) Design a linearizing circuit so that the resistance is approximately linear from 0C to +30C. Plot the resulting resitance vs. temperature relationship.

2) Using the linearizing circuit from problem 4, design a circuit which outputs

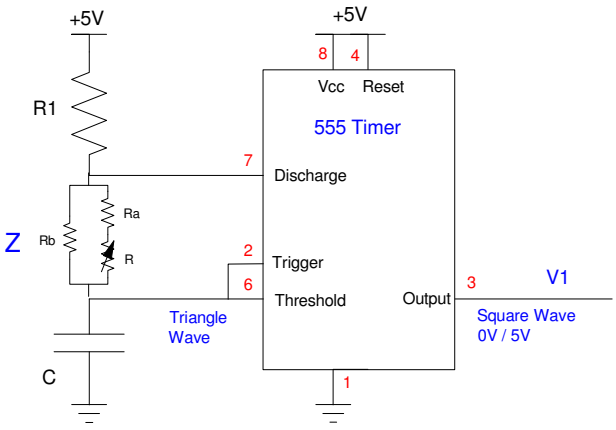
- 0V at 0C
- +5V at +30C
- Proportional in between.

Plot the resulting output voltage vs. temperature.



3) Using the linearizing circuit from problem 4, design a 555 timer which outputs 500Hz at +10C

- Determine the frequency it outputs from 0C to +30C



Calibration

4) Assume a thermistor is used with a 1k resistor to convert resistance to voltage:

$$V = \left(\frac{R}{R+1000}\right) 10V$$

Determine a calibration function to determine temperature given the voltage as

$$T \approx aV + b$$

over the range of (0C, +30C). What is the maximum error in your curve fit?

5) Repeat problem #4 with a cubic curve fit.

$$T \approx aV^3 + bV^2 + cV + d$$

Audio / Strain Sensors

6) A strain sensor is connected to a metal rod to measure the force applied to the center of the beam. Assume

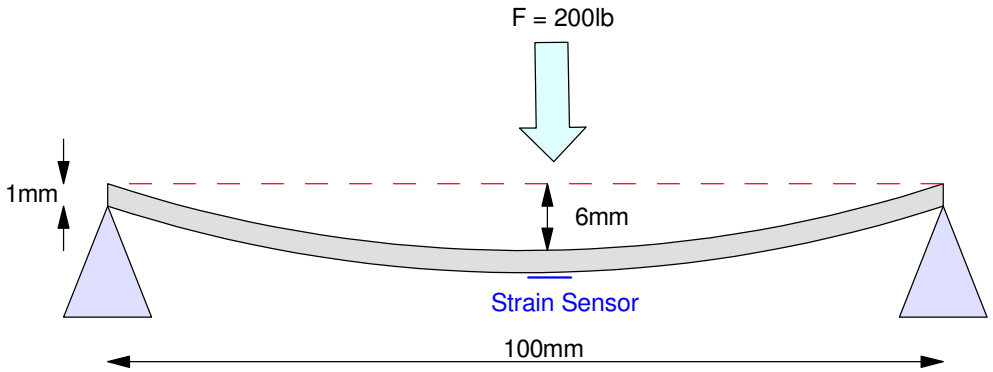
- The beam's thickness is 1mm,
- The beam's lenfgth is 100mm,
- The beam deflects 6mm when a force of 200lb is applied to it, and
- The strain - resistance relationship of the strain sensor is

$$R = 120(1 + 2.14\varepsilon)\Omega$$

a) Determine the strain and the resistance when the beam deflects by 6mm

b) Design a circuit which outputs

- 0V at 0lb force and
- +10V at 200lb force

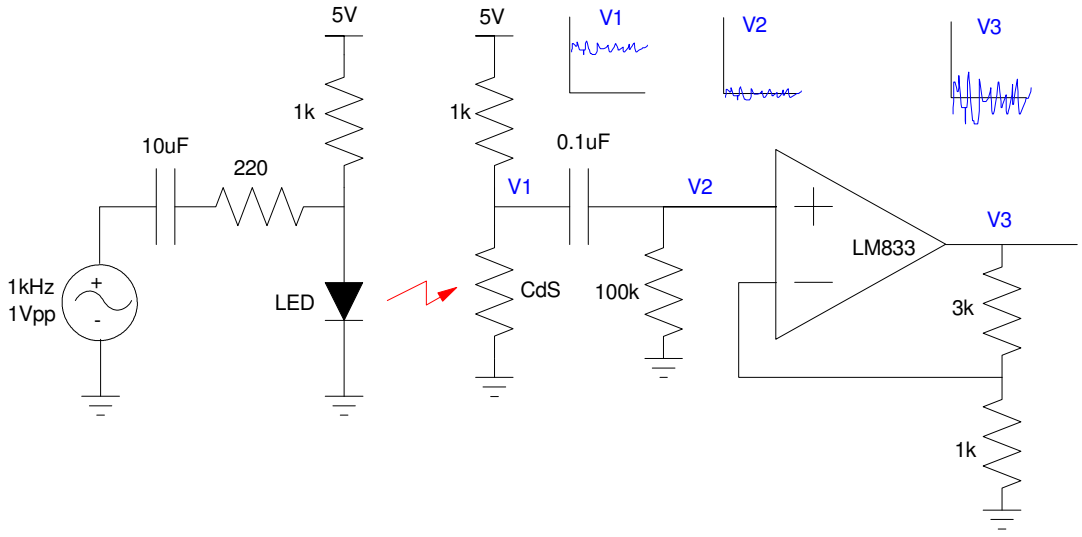


Sound to Light

7) Assume the CdS light sensor has a resitance of

$$R = 1000 + 50\sin(\omega t) \text{ Ohms}$$

determine the voltages at V1, V2, and V3 (both DC and AC. Peak-to-peak votlages are OK (and easier) for the AC voltages).



Hardware (option #1)

8) Design a circuit to amplify a condenser micropohone to 0..5V

Note: You can also use a speaker as a microphone. From duality

- If you apply a voltage to a speaker, it produces sound
- If you apply sound to a speaker, it produces voltage

9) Test your audio amplifier with your amplifier with the push-pull amplifier from homework set #1 and your amplifier in problem #8.

Hardware (option #2)

8) Build the light-to-sound circuit for problem #7. Measure the voltages for a 1kHz sine wave input.

9) Test your light-to-sound circuit with the push-pull amplifier from homework set #1 and an audio signal from your cell phone (or similar device).