

EE230- Analog lab (Homework-4)

Spring Semester: Year 2021-22

February 6, 2022

Instructions:

- Show your netlists and simulation results of each question to the evaluating TA.
 - **No Additional time will be given.**
 - **You can refer:** NGSPICE tutorial, model files uploaded on the course moodle / MS Teams channel and your written netlists of previous experiments.
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1. Question 1

- (a) Simulate the Wheat-stone bridge circuit shown in the figure [1]. Vary the resistor R_x as 300Ω , 305Ω , 310Ω . Plot the difference of the output values i.e. $V_a - V_b$. Don't forget to apply the supply voltage of $\pm 15V$.
- (b) Use the LM741 Op-amp used in the previous labs for difference amplifier. Connect the wheat-stone bridge to the inputs of the difference amplifier. Vary the value of resistor R_x as mentioned in the above part and plot the output of the difference amplifier.

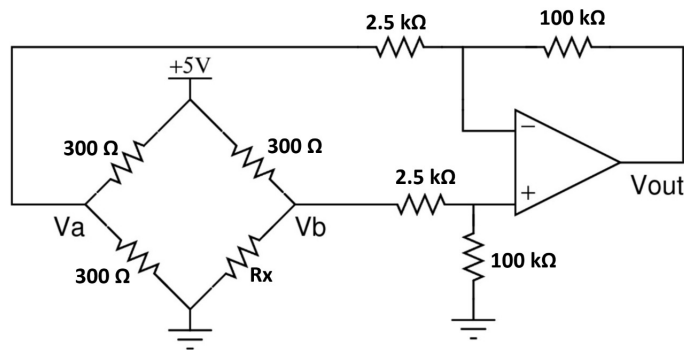


Figure 1: Op-amp based Wheat-Stone bridge Circuit

2. Question 2

- Characterize the thermistor and plot the resistance vs temperature for both PTC (positive value of α) and NTC (negative value of α).
- Simulate the Wheat-stone bridge circuit with a thermistor as shown in the figure [2]. Vary the temperature from 20° to 30° in steps of 0.1° . Plot the difference of the output values i.e. $V_a - V_b$. Don't forget to apply the supply voltage of $\pm 15V$.
- Connect the wheat-stone bridge to the inputs of the difference amplifier as shown in the figure [2]. Vary the temperature as mentioned in above part and plot the output of the difference amplifier.

Hint: How to give temperature input? You can vary a voltage source in place of varying temperatures to obtain the change in resistance at the output. You can use the subckt provided and can sweep the "temp.val" as an alternative for varying temperature

Note: A thermistor is a resistance thermometer, or a resistor whose resistance is dependent on temperature. There are two types of thermistors: Negative Temperature Coefficient (NTC) and Positive Temperature Coefficient (PTC). With an NTC thermistor, when the temperature increases, resistance decreases and for a PTC, when temperature decreases, resistance decreases. We can model the thermistor as a variable resistor. The following equation can be used to model the thermistor.

$$R = R_0 e^{\alpha \left(\frac{1}{T} - \frac{1}{T_0} \right)}$$

where α is the temperature coefficient, T_o is the ambient temperature, and R_o is value of resistance at T_o .

For more information, you can refer to the following website. Reference.

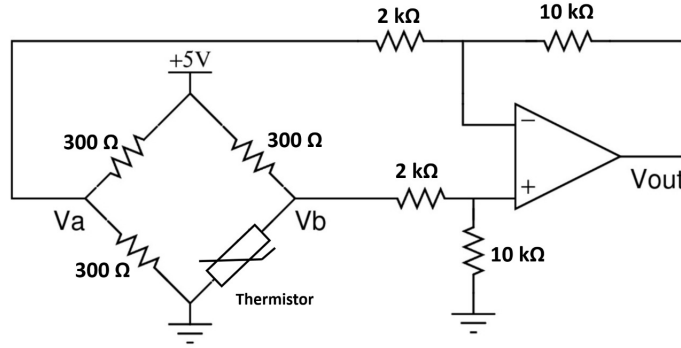


Figure 2: Op-amp based Wheat-Stone bridge Circuit with Thermistor