EE230- Analog lab (Homework-5)
Spring Semester: Year 2021-22

February 8, 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.

1. Question 1

   (a) Simulate the Wheat-stone bridge circuit shown in the figure [1]. Keep 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.
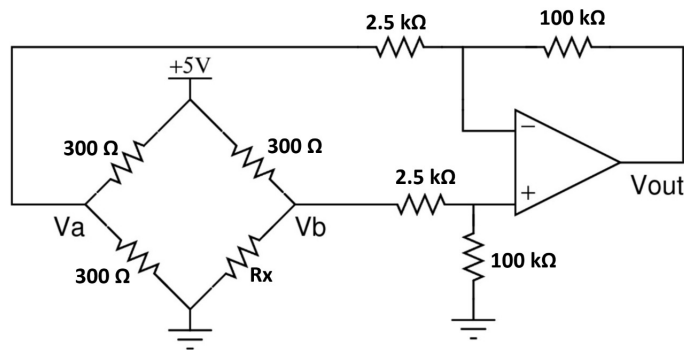

Figure 1: Op-amp based Wheat-Stone bridge Circuit

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2. Question 2

   (a) Characterize the thermistor and plot the resistance vs temperature for both PTC (positive value of α) and NTC (negative value of α).

   (b) 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^o. Plot the difference of the output values i.e. $V_a - V_b$. Don't forget to apply the supply voltage of $\pm 15V$.

   (c) 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 bridge. (In this case 1V corresponds to 1° 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.

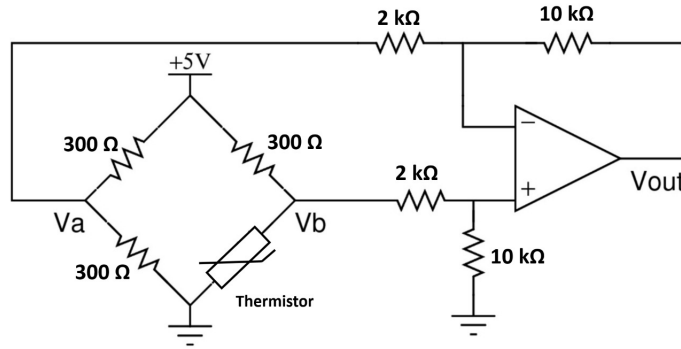For more information, you can refer to the following website. Reference.

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

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