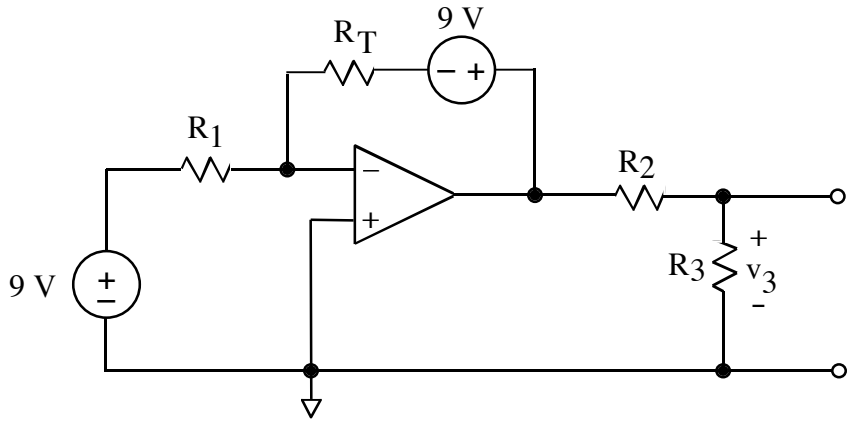
1. (75 points)



Rail voltages = ± 8 V

Design an electronic thermometer using the circuit diagram shown above. The voltage v_3 is used to indicate temperature. Use a thermistor with a resistance described by

$$R_T = R_o\, e^{2000\left(\frac{1}{T} - \frac{1}{300}\right)}$$

where R_o = 12 kΩ and T is temperature in °K.

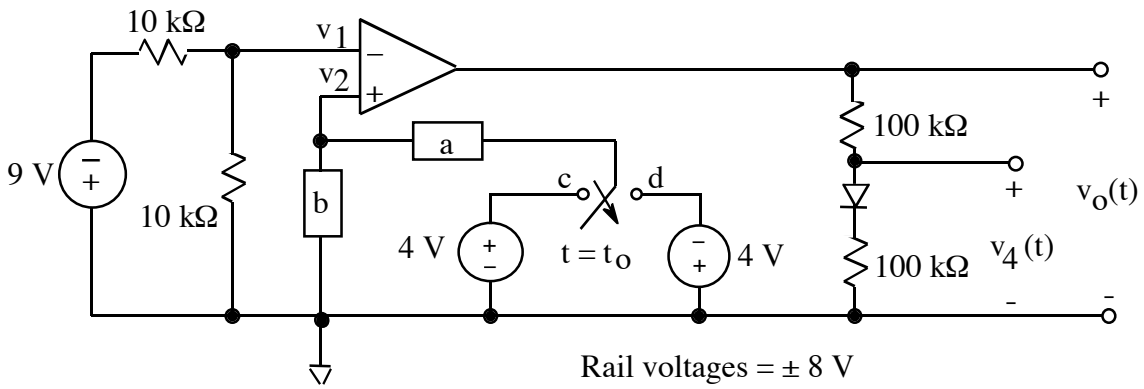
a. Choose circuit components that will produce the following:

v_3 = 0 V	when	T = 273°K
v_3 = 1 V	when	T = 373°K.

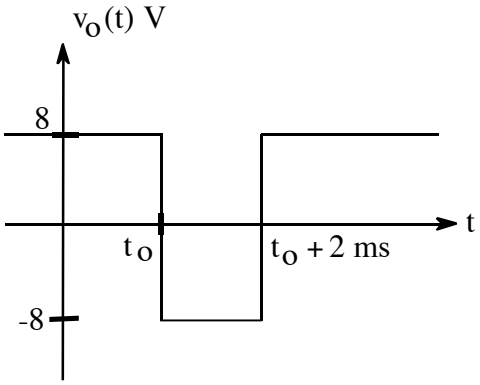
Be sure the operational amplifier would not saturate. Explain your work carefully.

b. Using the component values you chose above, calculate v_3 when T = 323°K. Make a rough sketch of v_3 vs. T on the basis of the values when T = 273°K, 323°K, and 373°K. On the same axes, sketch the ideal linear response. Comment on the quality of the response compared to the desired linear response.

2. (70 points)



After having been c for a long time, the switch is moved to position d at $t = t_o$.



a. Choose either an R or C to go in box a and either an R or C to go in box b to produce the $v_o(t)$ shown in the diagram. Specify which element goes in each box, and specify each value.

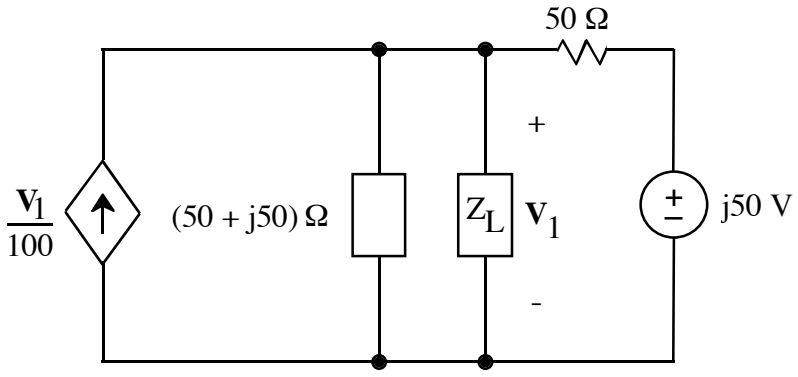
b. Sketch $v_2(t)$, the voltage across the circuit element in box b. Show numerical values appropriately.

c. Sketch $v_1(t)$, showing numerical values appropriately.

d. Sketch $v_4(t)$. Show numerical values for $t < t_o$, for $t_o < t < (t_o + 2\text{ ms})$, and for $t > (t_o + 2\text{ ms})$. Use the ideal model of the diode: when forward biased, its resistance is zero; when reversed biased, its resistance is infinite.

Explain your work carefully.

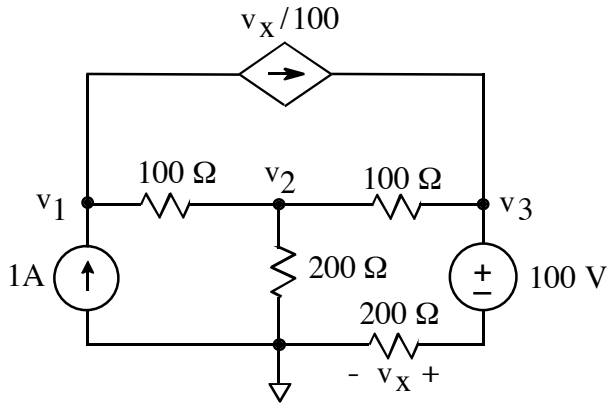
3. (30 points)



a. Choose the value of Z_L that will absorb maximum average power.

b. Calculate the value of that maximum average power absorbed by Z_L.

4. (25 points)



a. Write an equation for the node voltages v_1, v_2, and v_3 in the form:

$$g_{11}v_1 + g_{12}v_2 + g_{13}v_3 = i_1$$
$$g_{21}v_1 + g_{22}v_2 + g_{23}v_3 = i_2$$
$$g_{31}v_1 + g_{32}v_2 + g_{33}v_3 = i_3$$

List the numerical values of g_{ij}'s and i_j's.