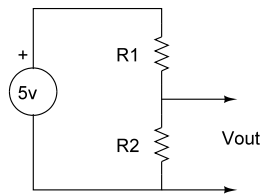


## ENGR-325 Hw #1

- 1) Show how op amps can be used to create an amplifier with a gain of +100 and an input impedance of 2.5 Kohms.
  - a) show how this can be done with a non-inverting configuration.
  - b) show how this can be done with an inverting configuration.
- 2) Resistance of a certain temperature sensor varies from 530 to 2400 ohms over the temperature range of interest. If this sensor is placed (as R2) in a voltage divider as shown with R1 equal to 500 ohms and 5 volts DC is applied, what is the range of voltages coming from the voltage divider?



- 3) Draw a graph of the output voltage versus sensor resistance from problem 2.
  - a) Does the voltage vary linearly with resistance?
  - b) Does the voltage decrease or increase with resistance increase?
  - c) If the sensor (R2) were swapped with resistor R1 does the output voltage increase or decrease as the sensor resistance increases?
- 4) A control system needs the average of temperature from three locations. Temperature sensors make the temperature information available as voltages V1, V2, and V3. Develop an op-amp circuit that outputs the average of these voltages. The input resistance for each input should be 10,000 ohms.
- 5) Modern sensors often produce an output voltage proportional to the affect being measured such as temperature or pressure. Such a sensor has an output impedance. With nothing attached to the sensor output terminals we can define its output as the open-circuit voltage. An electrical measuring instrument or amplifier has an input impedance. If the sensor is connected to a measuring instrument or amplifier loading can occur which means the output voltage is lower than the open-circuit voltage for the same temperature or pressure. Plot the ratio (measured-voltage)/(open-circuit-voltage) as the **input** impedance of the measuring device varies from 1:1 to 1:10,000 (just look at each order of magnitude). What value (i.e. ratio) of input impedance would be acceptable in a quality instrument?
- 6) Sensors sometimes create an output current, rather than voltage, that is proportional to the parameter being measured. Assume a pressure sensor creates an output that is 4ma for zero (gage) pressure and 20ma for 32 psi. Design a circuit that will convert this to a voltage where zero psi produces +4 volts and 32 psi produces +20 volts.