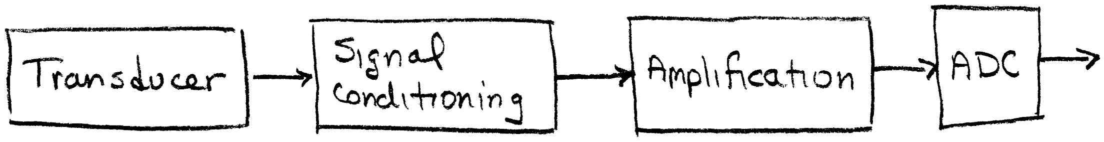
Instrumentation Systems

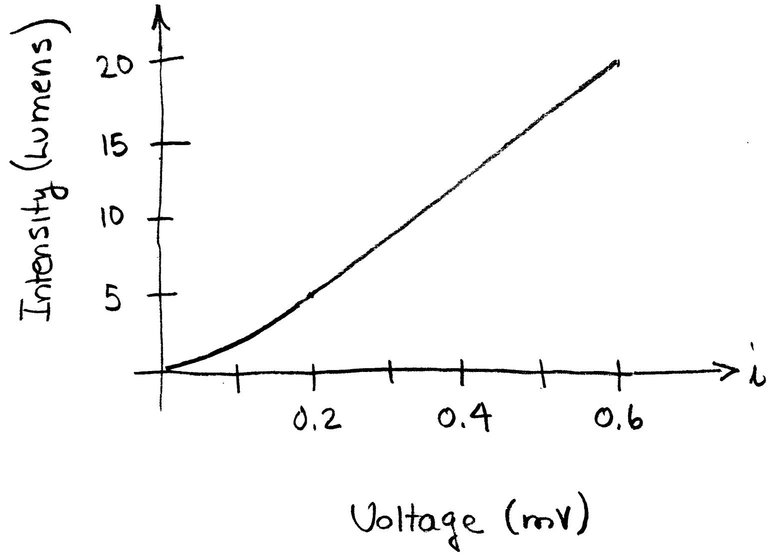


can be filtering, linearization, etc.

converts analog to digital

need amplification to get signal up to useful level.

Example



Characteristics of photocell transducer

Need to measure 5-20 lumens input to a 0-5V ADC

We need to convert

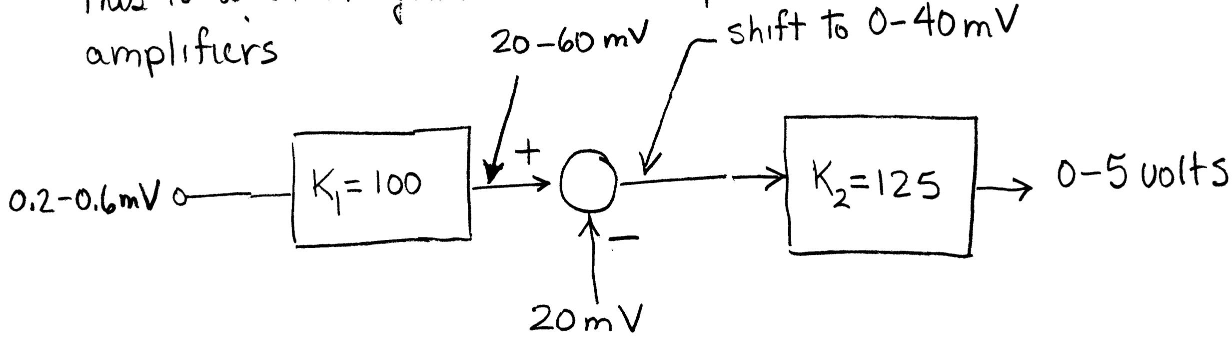
physical input	from transducer	to ADC
5 lumens →	0.2 mV →	0 volts
20 lumens →	0.6 mV →	5 volts

This requires an amplifier with a DC offset

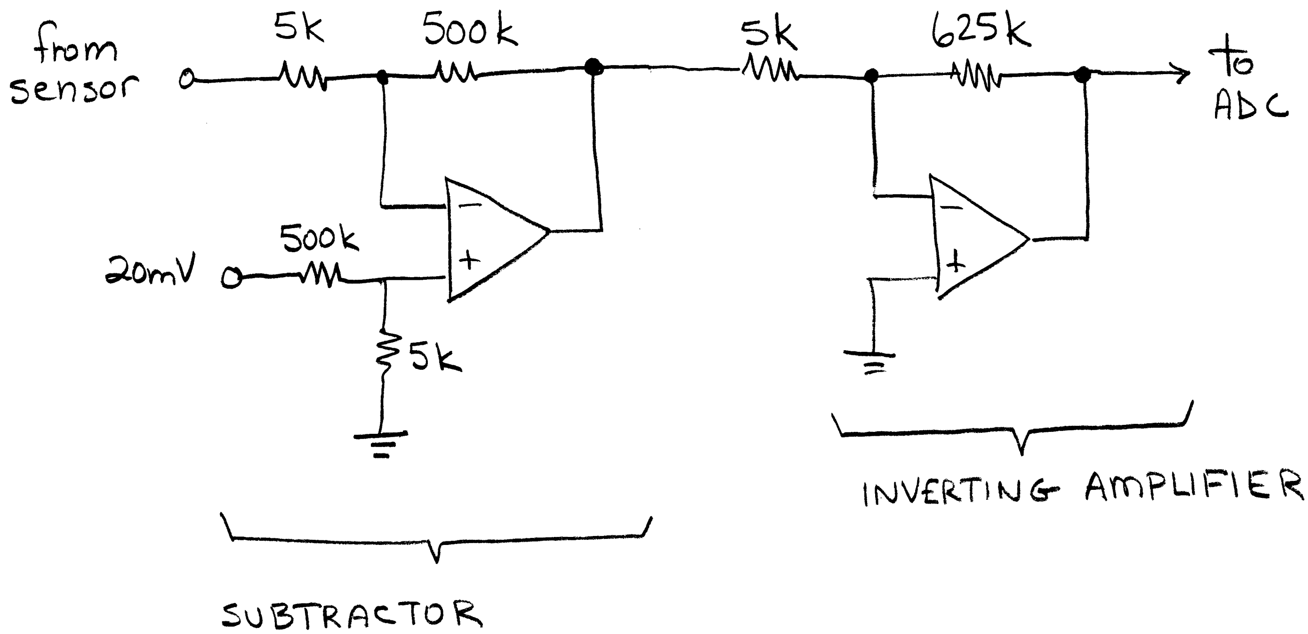
The amplifier gain necessary is

$$K = \frac{\text{desired output}}{\text{transducer output range}} = \frac{5-0}{(0.6-0.2)\times 10^{-3}} = 1250$$

This is a lot of gain so we implement it as two amplifiers



Possible amplifier solution

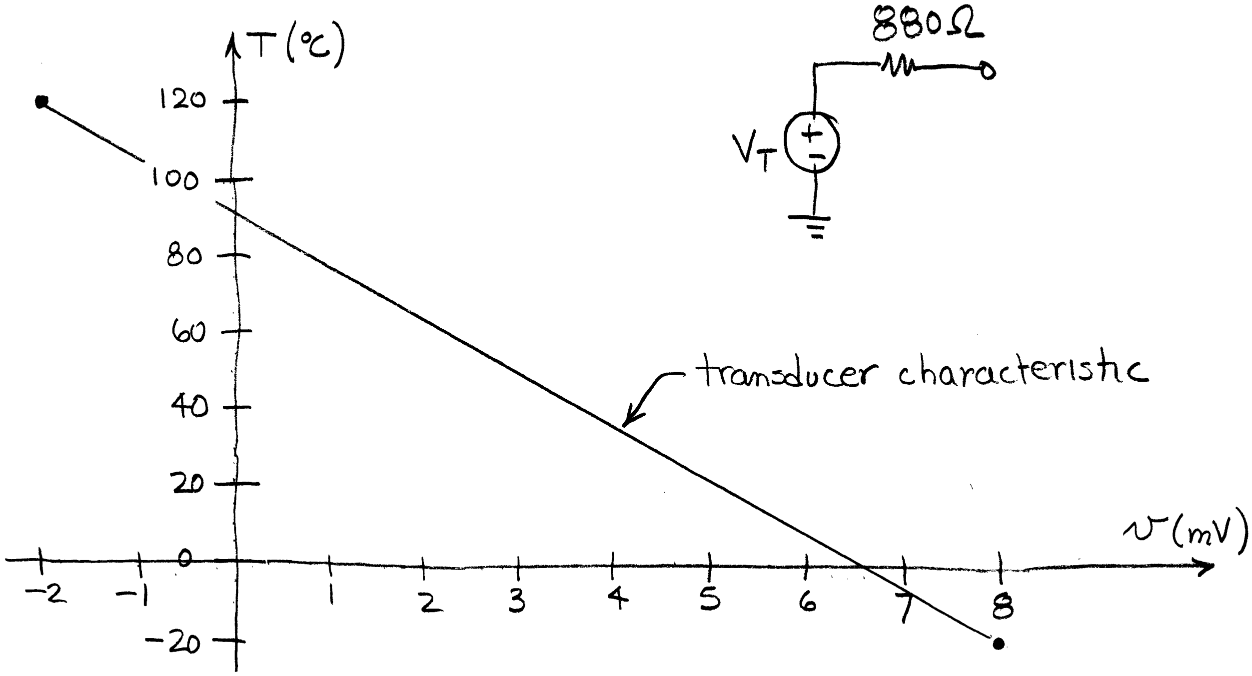


$$K_1 = -\frac{R_2}{R_1} = \frac{-500k}{5k} = -100$$

$$K_2 = \left(\frac{R_1+R_2}{R_1}\right)\left(\frac{R_4}{R_3+R_4}\right) = \frac{(5k+500k)}{5k}\left(\frac{5k}{5k+500k}\right) = 1$$

Design Exercise 4-16

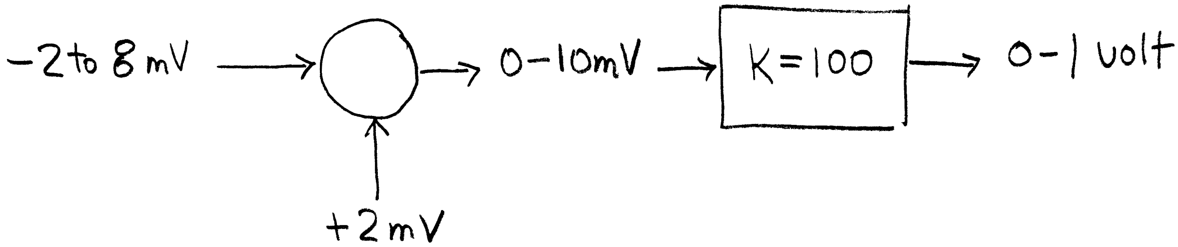
Design an OP AMP circuit to translate the temperature range −20°C to +120°F to a 0–1 volt signal using the following sensor characteristics. The transducer has a Thevenin resistance of 880Ω.



The required gain is

$$K = \frac{\text{output range}}{\text{input range}} = \frac{1-0}{8-(-2)\times 10^{-3}} = 100$$

The ranges are

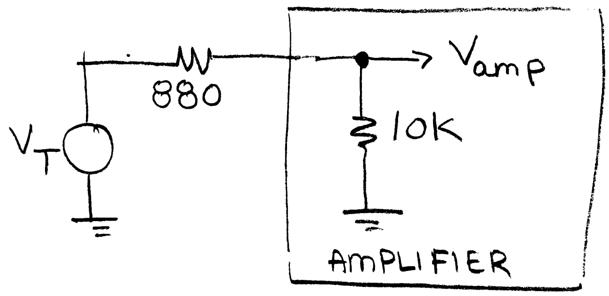


There are many ways to implement this

But we have a consideration other than gain

$R_{TRANSDUCER} = 880\Omega$

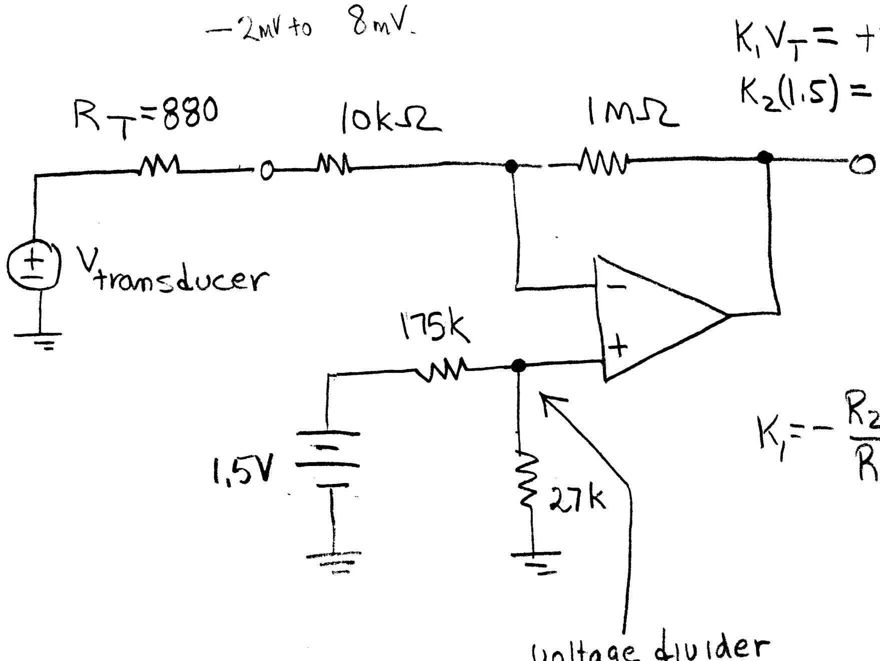
We need R_{IN} for the amplifier to be at least 10x time to prevent loading – a voltage divider which would lead to only a fraction of the transducer signal being properly amplified.



Pick R_{IN} for amplifier to be 10k. Then

$$V_{amp} = \frac{10k}{880+10k} V_T \cong .92$$

We can use a subtractor circuit as shown below



$K_1V_T = +200mV$ to $-800mV$

$K_2(1.5) = -202mV$

$$K_1 = -\frac{R_2}{R_1} = -\frac{1M\Omega}{10k\Omega} = -100$$

voltage divider

$$v_p = \frac{27k}{27k+175k}(1.5) = 0.200 \text{ volts}$$

$$K_2 = \left(\frac{10^6+10^4}{10^6}\right)\left(\frac{27k}{175k+27k}\right) = .135$$