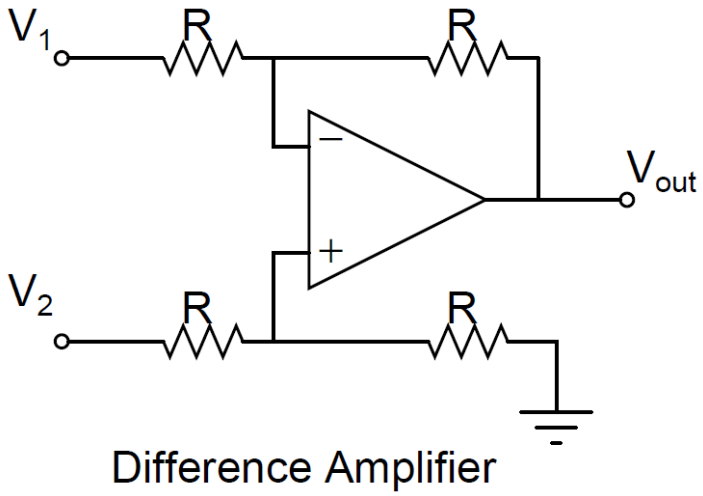
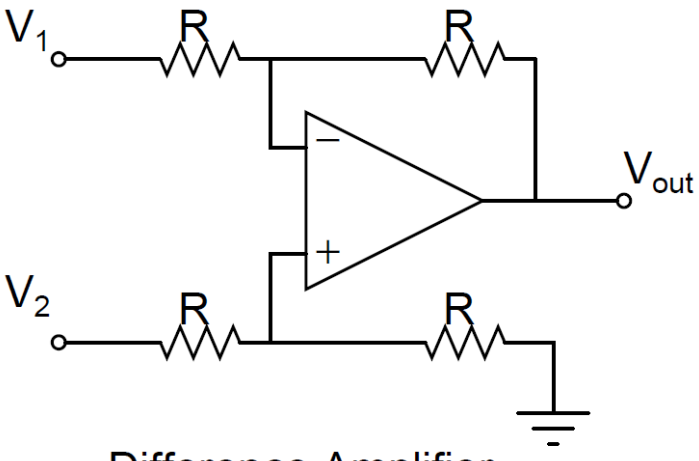
Difference Amplifier



Difference Amplifier

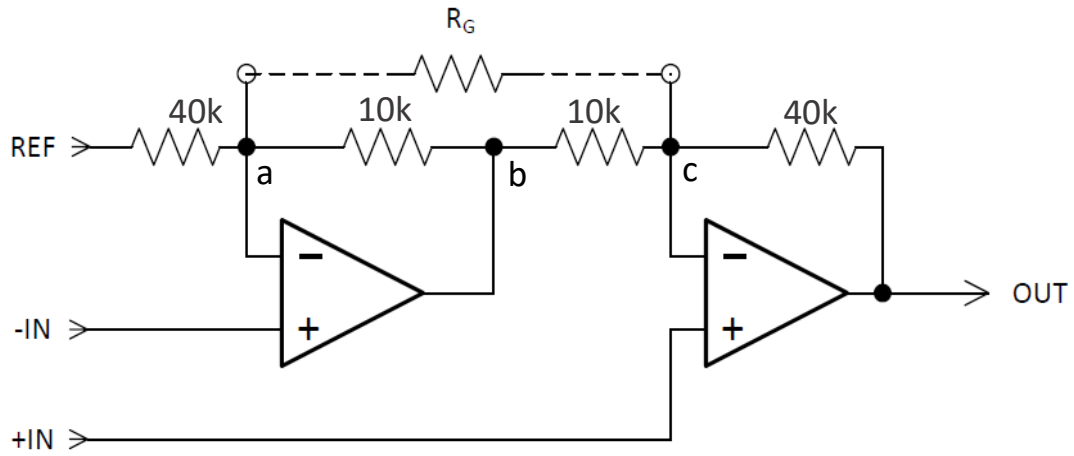
1. Show that for the difference amplifier: $V_{out} = V_2 - V_1$



Difference Amplifier

2. Then use the diagram above to show what real voltages sources look like. Real sources consist of an ideal voltage source plus a resistor (or impedance element). Will the output still be Vout = V2 – V1. Why or why not?

Instrumentation Amplifier



The internal circuitry of the INA126 instrumentation amp is shown above (adapted from: http://www.ti.com/lit/ds/symlink/ina126.pdf)

1. Show that:

   $V_{out} = G\,(V^{+}_{in} - V^{-}_{in}) + V_{REF}$ [Eqn 1]

   , where $G = 5 + 80k\Omega/R_G$ is the voltage gain

Hint: write a system of 2 equations, 1 for each of the op-amps. Of course, use KCL, Ohm's Law and the op-amp golden rules (why do they apply?). Carefully draw currents and apply Ohm's law across each resistor.

2. How do you interpret the physical meaning of Eqn 1? What does the first term on the RHS represent? What does G represent? How about the second term, what does Vref represent?
3. Imagine that you use a select RG = 1.2 k, set Vref = 1.8 V, and $V^{+}_{in} - V^{-}_{in}$ =100 μV sin(2π100 t). Sketch the corresponding output voltage Vout.
4. What are 2 distinct advantages the instrumentation has over the basic difference amp? To help answer this question, add to the circuit diagram 2 real voltage sources, 1 each connected to V^{+}_{in} and V^{-}_{in}.