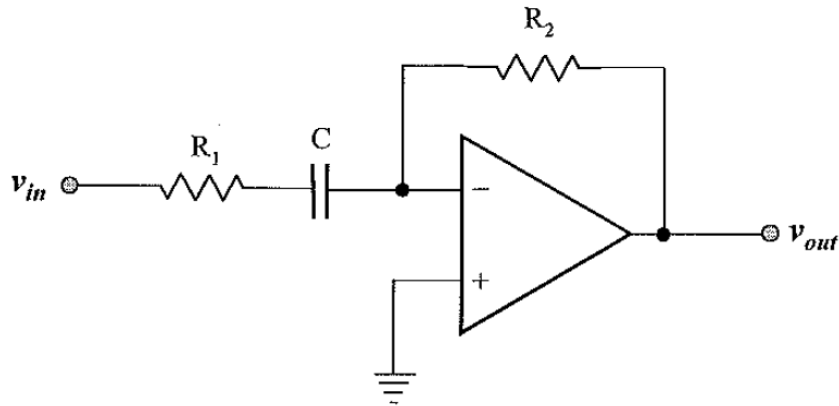# Physics 623
The Operational Amplifier: Lab worksheet

1) In the lecture we have shown how to construct an integrator using an op-amp. With an op-amp it is possible to construct many mathematical operations. Another example is differentiation.
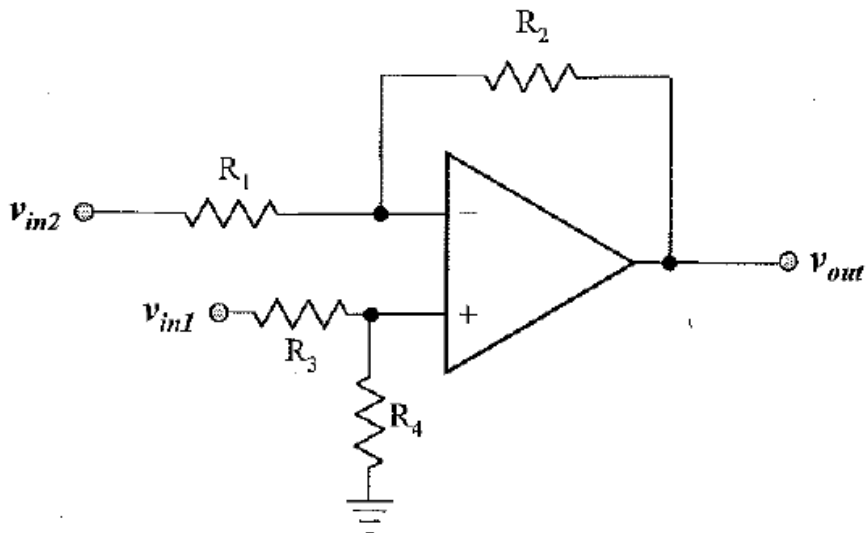
    a) Find the relation between Vin and $Vaut$ for the circuit below:

    b) Show that when $R_1 << \dfrac{1}{\omega C}$ $(\Rightarrow \omega << \dfrac{1}{RC})$, the circuit works as a differentiator. How does the differentiation error depend on the frequency of v_{in}?. Find v_{out} when $R_1 >> \dfrac{1}{\omega C}$ $(\Rightarrow \omega >> \dfrac{1}{RC})$.

2) With an op-amp, one can also construct a difference amplifier.

a) How does the output voltage relate to the two input voltages in the circuit below:

b) Show that when $R4 / R3 = R2 / R1$, the circuit works as a difference amplifier. What is the voltage gain for a difference input? (Differential gain $A_D \equiv \dfrac{V_{OUT}}{(V_{in-1} - V_{in-2})}$.) What is the voltage gain for a common-mode input? (Common mode gain $A_C \equiv \dfrac{V_{OUT}}{(V_{in-1} + V_{in-2})/2}$.)

3) In the below circuit, show that the current flowing through the load resistor, I_L, is independent of the load, R_L. What is *Vout* ? This circuit constitutes a constant current source with a grounded load.