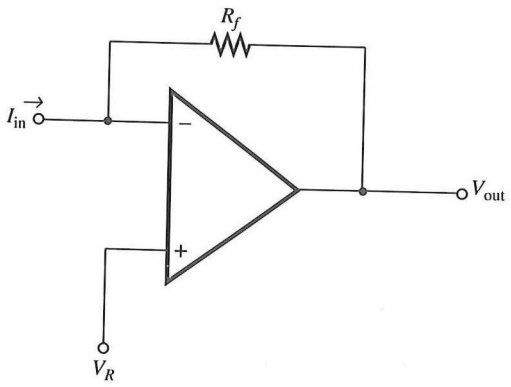
Physics 313 assignment for Thursday Oct 6:

1. In the derivation of V_{out} for the op amp integrators and differentiators, do we need to assume that V_{out} is small?

2. a) What does the circuit at right do (Assume V_R=0)? Explain using the golden rules of op-amps.



b) What is the maximum current that can be measured (without saturating the op amp) in the figure at right if R_f is 10 M? Assume ±15 V supplies are being used to power the op amp.

3) The slew rate of an op amp is the maximum rate at which the output voltage can change—that is, SR= $dV_{out}/dt)_{max}$. This means that for signals that change very quickly, the output may be distorted because the op amp can't "keep up." Let's see what happens when the signal is a sine wave.

a) Assume that $V_{in}=V_0\sin(\omega t)$, and that the voltage gain of the op amp circuit is A_V. Write an expression for V_{out}.

b) Now take the derivative to obtain an expression for dV_{out}/dt. Where in the cycle does the largest value of dV_{out}/dt occur, and what is this value?

c) The output will begin to be distorted when the largest value of dV_{out}/dt is equal to the slew rate (SR) of the op amp. Use your result from b) to find an expression for the frequency (in Hz) at which distortion will start to occur (your answer should depend on A_V, V_0, SR, and constants).

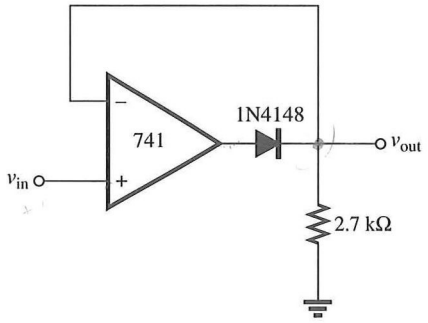
d) Search online for a datasheet for the LF411 op amp (or use the one in the lab) and from the datasheet find a value for the typical slew rate. Then use this and your result from c) to find the highest frequency sine wave signal with amplitude 10 V for which the output of a follower based on this op amp will be undistorted.

4) a) Design an inverting amplifier using an ideal op amp. Make the input impedance 5k and the voltage gain -25.

b) Design a non-inverting amplifier using an ideal op amp. Make the voltage gain 25. What is the input impedance?

(over)

5) Sketch a graph of Vout vs Vin for the circuit at right; assume that V_{in} is a sine wave of amplitude 2 V and frequency 1 kHz. Use the Golden Rules to explain how you got your answer. Hint: Consider what happens when $V_{in}>0$, and then consider what happens when $V_{in}<0$. Note: in the figure, there should be a connection at the point where the lead from the diode crosses the lead to the resistor.



6) The circuit shown at right is a difference (sometimes called differential, but not in the calculus sense) amplifier. What is Vout in terms of the input voltages Va and Vb. Start from the Golden Rules and derive the equation for V_{out}/V_{in} (your answer will also depend on R_2 and R_1). There's a similar example in the text, which you can use to check your work, but don't just plug into the text equation.