Homework #4
Due Date: May 9, 2008 (by 5pm)

1. The inputs to the circuit below a current source $i_S$ and a voltage source $v_S$. When the Op Amp in its linear range, the output voltage has the form $v_O = K_1 v_S + K_2 i_S$. Find $K_1$ and $K_2$.

2. The op amp in the circuit below is ideal. What is the gain $v_O/v_S$ in the circuit when the switch is in position 1? Repeat for positions 2 and 3. Compare the results.
3. Find $v_O$ in terms of the inputs $v_{S1}$ and $v_{S2}$. Assume the Op Amp is ideal.

4. Use node-voltage analysis in the circuit below to show that the circuit is a voltage controlled current source. (Hint: show that $i_O = -v_S/2R$ regardless of the load) Assume the op amp is ideal.

5. What is the range of the gain $v_O/v_S$ in the circuit below. Assume the Op Amp is ideal.
6. The circuit inside the red box in the figure below is a constant current source for a limited range of values of $R_L$.
   a) Find the value of $i_L$ for $R_L = 4k\Omega$.
   b) Find the maximum value for $R_L$ for which $i_L$ will have the value in (a).
   c) Assume that $R_L = 16k\Omega$. Explain the operation of the circuit. You can assume that $i_n = i_p = 0$ under all operating conditions.
   d) Sketch $i_L$ versus $R_L$ for $0 \leq R_L \leq 16k\Omega$.

![Circuit Diagram](image)

7. Design an inverting summing amplifier so that:

   $$v_o = -(2v_a + 4v_b + 6v_c + 8v_d)$$

   If the feedback resistor ($R_f$) is chosen to be $56k\Omega$, draw a circuit diagram of the amplifier and specify the values of $R_a$, $R_b$, $R_c$, and $R_d$.

8. The op amps in the circuit shown are ideal. Find the output $v_2$ in terms of $v_1$.
9. In the difference amplifier shown below, what range of values of $R_x$ yields a $CMRR \geq 1000$?

![Difference Amplifier Diagram]

10. Find the output $v_2$ in terms of the input $v_1$ in the circuit below. Assume the Op Amps are ideal.

![Circuit Diagram]