Problem Set #8 (125pts) Due 29 Oct before lecture.
Please refer to the lecture notes: Notes on Operational Amplifiers for Op Amp circuit analysis procedures. Show your work. Show the algebra you use to solve the problem. If a numerical result is requested, show how it is obtained from your solution. Show the substitutions into the equations. Put a box around your answers.

Instructions for problems 1-5. A detailed circuit analysis is not required for 1 through 5. Compare circuits 1-5 with the standard circuits in the lecture handout. For each circuit, state which of the standard circuit(s) it is like. In some cases the circuit may be a combination of two or more of the standard circuits. A switch may change the circuit from one type to another. Having determined what type of circuit you have, write the equation for the gain starting from the result for the standard circuit. If you get stuck or simply want to verify your reasoning, you can always use the Op Amp rules and arrive at the solution.

1) 15 pts. In the following circuit, the switch can have two positions, open and closed. What is the gain \( \frac{V_{out}}{V_{in}} \) for both positions of the switch?

2) 15 pts. In the following circuit the switch can have two positions. In one position, the + input is connected to \( V_{in} \), in the other, it is connected to ground. What is the gain \( \frac{V_{out}}{V_{in}} \) for both positions of the switch?

3) 15 pts. In this circuit \( V_{out} = k_1V_1 + k_2V_2 \). What are the gains \( k_1 \) and \( k_2 \)? (Be careful of the signs.)
4)  **15 pts.** What is the gain ($V_{\text{out}}/V_{\text{in}}$)? (Note that all the resistors are the same value.)

5)  **15 pts.** In this circuit $V_{\text{out}} = k_1 V_1 + k_2 V_2 + k_3 V_3$. What are the gains $k_1$, $k_2$, and $k_3$?

6)  **25 pts.** What is the gain ($V_{\text{out}}/V_{\text{in}}$) of this circuit? (For this circuit you will need to use the Op Amp rules and determine the gain using Kirchhoff’s and Ohm’s law.)

7)  **25 pts.** A) Find $V_{\text{out}}$ in terms of $V_{\text{in}+}$, $V_{\text{in}-}$, $R_1$, $R_2$, $R_3$, and $R_4$ for the general case where the four resistors can all have different values. Follow the example in the lecture notes.

    B) Show that for the special case of $R_4 = R_2$ and $R_3 = R_1$ your result reduces to $V_{\text{out}} = \frac{R_2}{R_1} (V_{\text{in}+} - V_{\text{in}-})$. 