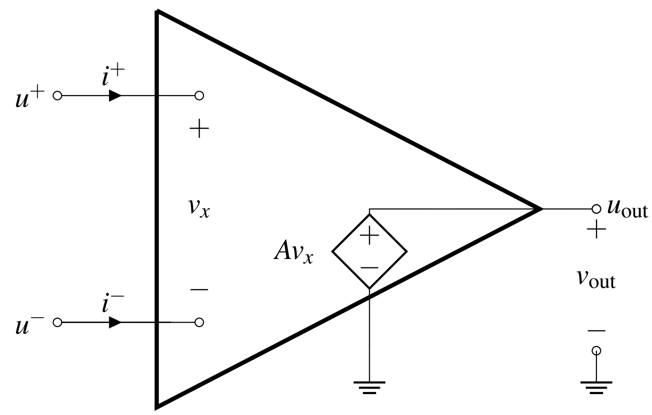
EECS 16A Designing Information Devices and Systems I
Spring 2023 Discussion 11B

1. Op-Amp Rules

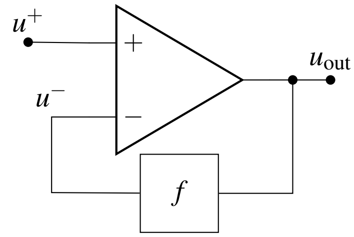
Here is an equivalent circuit of an op-amp (where we are assuming that $V_{SS} = -V_{DD}$) for reference:



(a) What are the currents flowing into the positive and negative terminals of the op-amp (i.e., what are i^+ and i^-)? Based on this answer, what are some of the advantages of using an op-amp in your circuit designs?

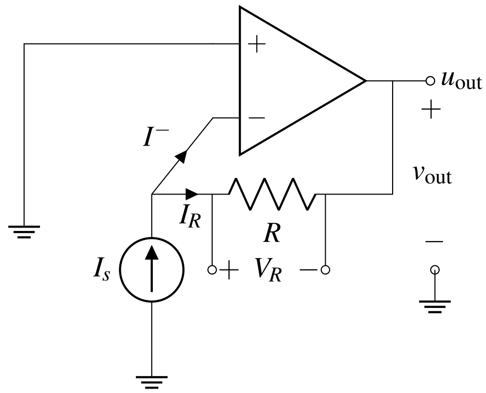
(b) Suppose we add a resistor of value R_L between u_{out} and ground. What is the value of v_{out}? Does your answer depend on R_L? In other words, how does R_L affect Av_C? What are the implications of this with respect to using op-amps in circuit design?

(c) Now suppose our op-amp is connected in negative feedback.



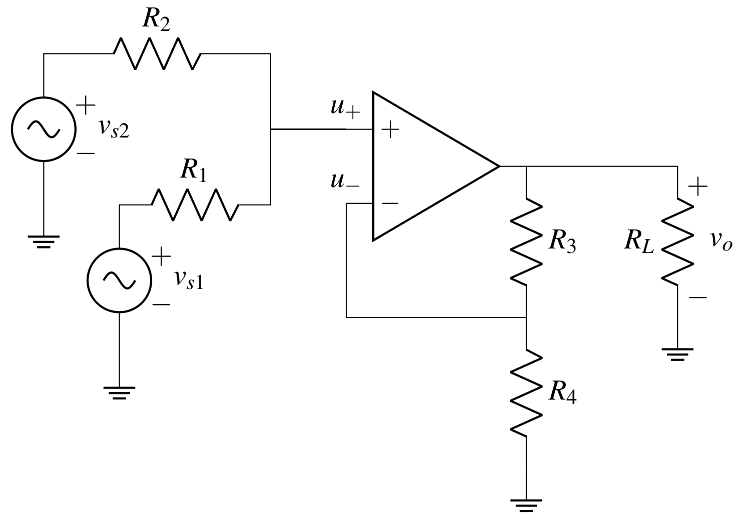
What is the relationship between u^+ and u^-?

2. A Trans-Resistance Amplifier



Calculate v_{out} as a function of I_s and R.
Hint: First show that the op-amp is in negative feedback and then apply the golden rules.

3. Multiple Inputs To One Op-Amp



(a) First, let's focus on the left part of the circuit containing the voltage sources v_{s1} and v_{s2}, and resistances R_1 and R_2. Solve for u_+ in the circuit above. *(Hint: Use superposition.)*

(b) How would you choose R_1 and R_2 that produce a voltage $u_+ = \frac{1}{2}V_{s1} + \frac{1}{2}V_{s2}$? Could you also achieve $u_+ = \frac{1}{3}V_{s1} + \frac{2}{3}V_{s2}$?

(c) Now, for the whole circuit, find an expression for v_o.

(d) How should we select our values R_1, R_2, R_3, R_4 to find the sum of different signals, i.e. $V_{s1} + V_{s2}$? What about taking the sum and multiplying by 2, i.e. $2(V_{s1} + V_{s2})$?