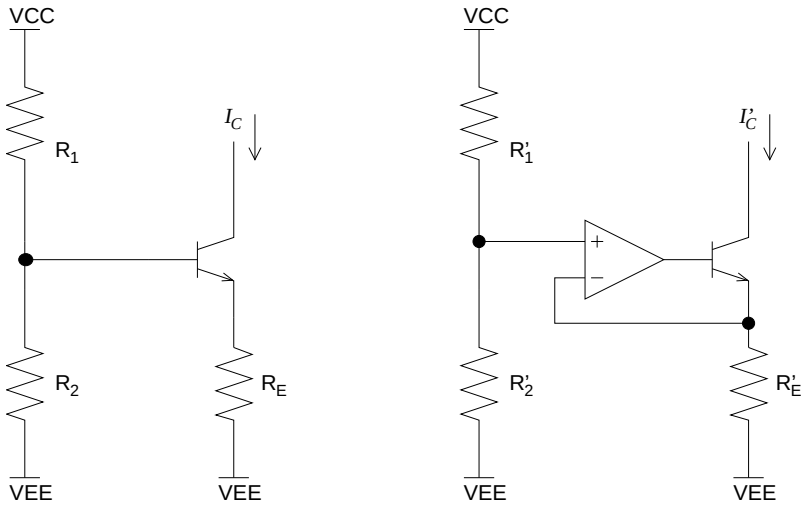
Physics 536 - Assignment #8 - Due April 7th

1. Consider the following two current source circuits, in which $V_{CC} = 10$ V and $V_{EE} = -10$ V:

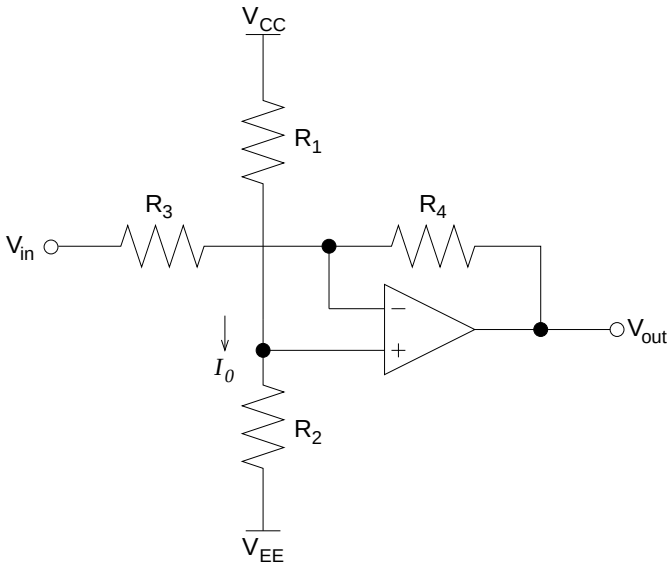


(a) Derive the relationship between the values of R_1, R_2 and R_E that will produce a desired current I_C in the circuit on the left.
(b) Derive the relationship between the values of R_1', R_2' and R_E' that will produce a desired current I_C' on the right.
(c) What is the advantage of using the circuit on the left when a load applied to the current source changes at a high frequency?
(d) What is the advantage of using the circuit on the right when the current I_C' is constant but the temperature of the circuit changes?

2. Determine the values of the resistors R_1, R_2, R_3 and R_4 that will produce the linear relationship between the input and output voltages:

$$V_{out} = a + bV_{in} \tag{1}$$

in the following circuit:

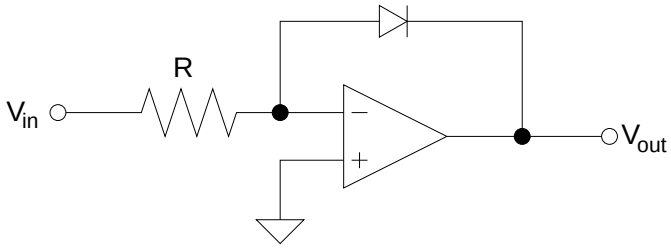


As a constraint, suppose that the current used by the voltage divider between V_{CC} and V_{EE} specified to be I_0.

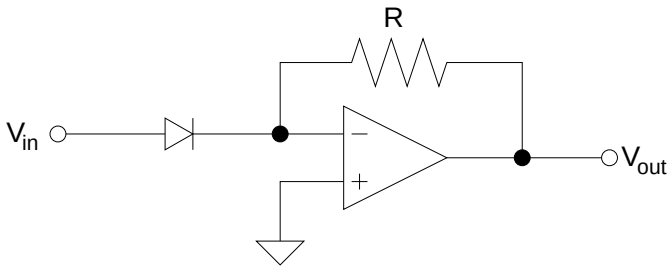
3. The relationship between the current, I, through the diode and the voltage drop, V, across it is

$$I = I_0 e^{eV/kT} \tag{2}$$

when $I \gg I_0$. Determine the relation between V_{out} and V_{in} in the following *logarithmic amplifier* op-amp configuration:



4. Determine the relation between V_{out} and V_{in} in the following *exponential amplifier* op-amp configuration:



5. Describe qualitatively how to construct an circuit that produces an output voltage that is proportional to the *product* of two input voltages. Sketch the circuit configuration that would achieve this, but do not explicitly calculate any component values.