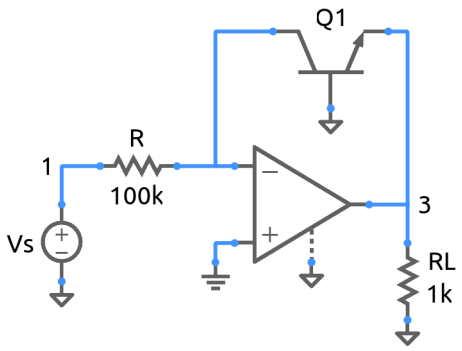
opamp_log.sqproj



In a BJT operating in the active mode, the collector current I_C is an exponential function of the base-emitter voltage V_{BE}, given by

$$I_C \approx I_{CS} \exp\left(\frac{V_{BE}}{\eta\, V_T}\right) , \tag{1}$$

where $V_T = k_B T/q$ is the thermal voltage. In the circuit shown in the figure, assuming the Op Amp to be operating in the linear region, the collector of the BJT is at virtual ground, and the BJT operates in the active mode as long as the current through the resistor R is positive (going from left to right). For this condition, we can write

$$I_C = \frac{V_s}{R} = I_{CS} \exp\left(\frac{V_{BE}}{\eta\, V_T}\right) = I_{CS} \exp\left(\frac{-V_o}{\eta\, V_T}\right) . \tag{2}$$

The above equation can be rewritten as

$$V_o = -\eta\, V_T \log\left(\frac{V_s}{R\, I_{CS}}\right) . \tag{3}$$

Exercise Set

1. Run the simulation. Plot V_o (linear scale) versus V_s (log scale). Comment on the plot. Estimate the value of I_{CS}.

2. How will the plot change if R is changed from 100 kΩ to 10 kΩ? Verify with simulation.

References

1. J. Millman and A. Grabel, *Microelectronics,* McGraw-Hill, 1988.