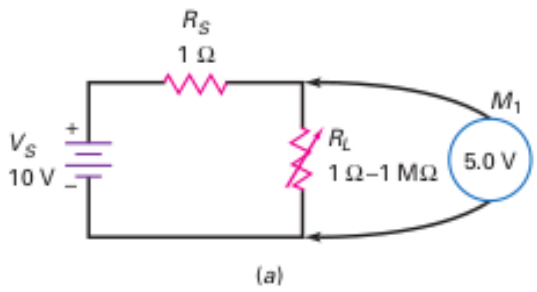
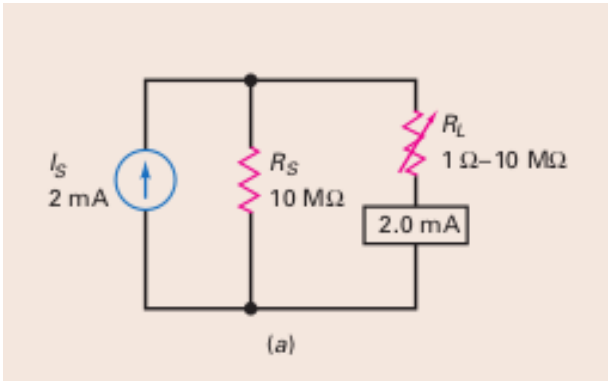
OpAmp Tutorial Sheet

Q1. In the above figures, we see a voltage source with a source resistance connected

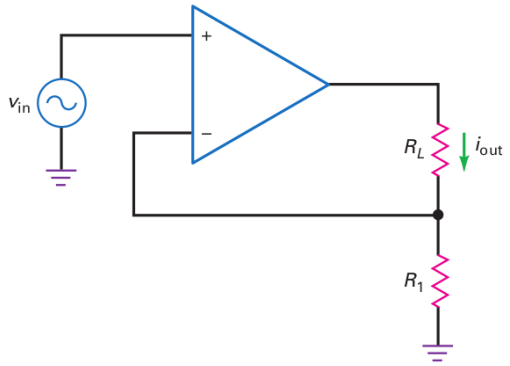


to a load. In the case of the case of the voltage source, the voltage across the load is $v_{out} = [R_L/(R_S + R_L)] * v_s$. We have $v_{out} = v_s$, when the load is open (i.e. $R_L \to \infty$) and $v_{out} = v_s/2$ when $R_L = R_S$. We used this fact to figure out the closed loop output impedance of VCVS in the class. We can use a similar argument with current source also.



The above figure shows a current source with a source resistance R_S *in parallel* and a load resistance R_L. Part of the current goes through R_S and part through R_L. Obtain an expression for the current through the load i_L, in terms of i, R_S and R_L. It is straight-forward to see that $i_L(R_L = R_S) = i_L(R_L = 0)/2$. We can use this fact to obtain the output resistance on VCCS

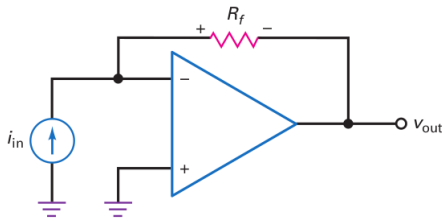
Q2. For the Voltage Controlled Current Source, in the figure above, show that



- $$i_L = \frac{1}{R_1 + \frac{R_1+R_L}{A_{VOL}}} v_{in} \approx \frac{1}{R_1} v_{in},$$

  that is, the load current depends purely on v_{in} and is independent of R_L and A_{VOL}.
- $z_{in(CL)} = (1 + A_{VOL}B)R_{in}$, where $B = R_1/(R_L + R_1)$.
- $z_{out(CL)} = (1 + A_{VOL})R_1$.

Q3. For the Current Controlled Voltage Source (CCVS) in the figure above, show

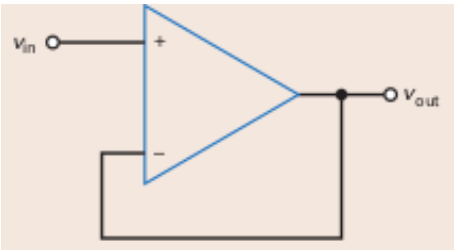


that

- $$v_{out} = -\frac{A_{VOL}}{1 + A_{VOL}} R_f i_{in} \approx -R_f i_{in},$$

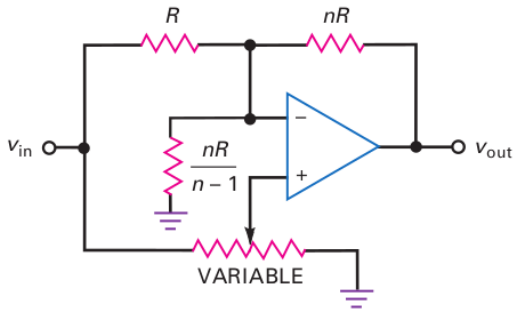
  that is, the output voltage depends purely on input current.
- $z_{in(CL)} = R_f/(1 + A_{VOL})$.
- $z_{out(CL)} = R_{out}/(1 + A_{VOL})$.

Q4. It is straight-forward to see that, in the above circuit, $v_{out} = v_{in}$. What, then,



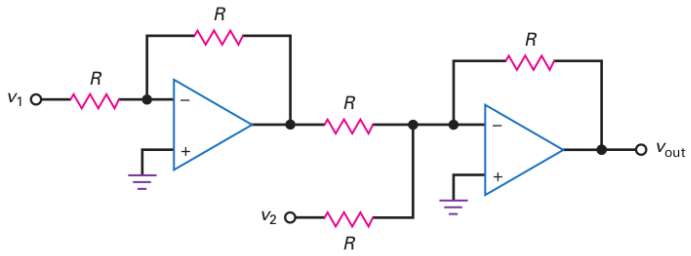
is the purpose of the OpAmp?

Q5. Show that, in the figure above, the voltage gain varies from $-n$ to $+n$, as the

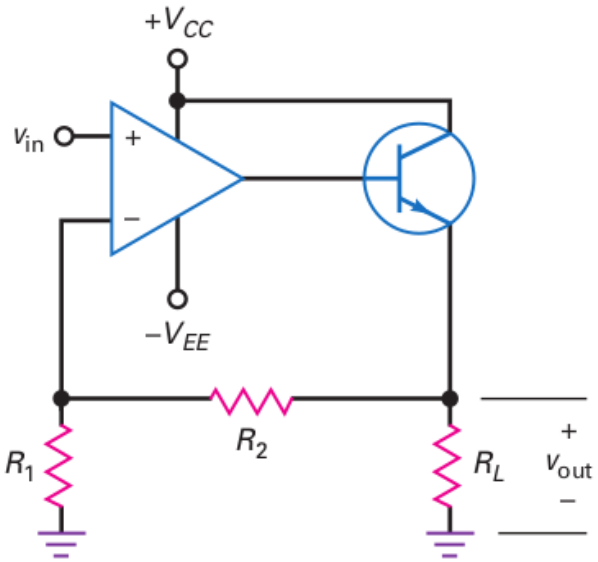


contact of the variable resistor is moved from the right end to the left end.

Q6. Obtain the relation between v_{out}, v_1 and v_2.



Q7. Calculate the voltage gain and $z_{out(CL)}$. What is the purpose of the transistor



in this circuit?