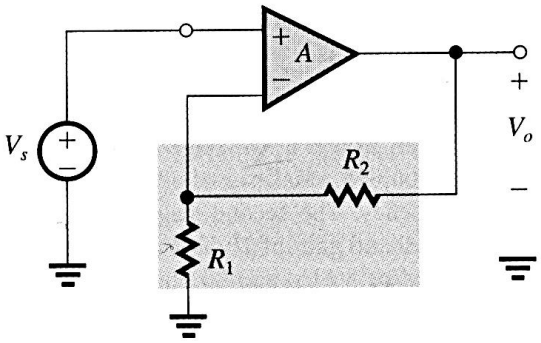
COLORADO STATE UNIVERSITY
ECE 332: ELECTRONIC PRINCIPLES II

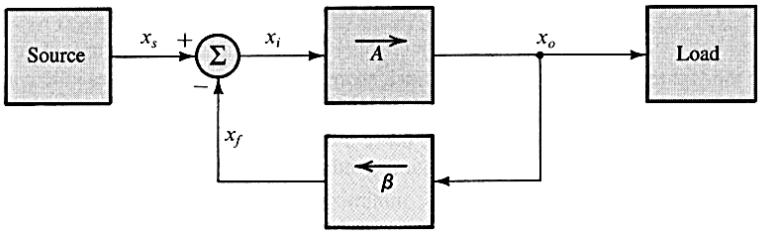
HOMEWORK 11

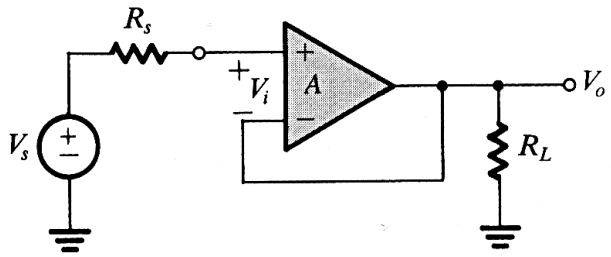
1. A negative-feedback amplifier has a close loop gain $A_f = 100$ and an open-loop gain $A = 10^4$. What is the feed-back factor f? If a manufacturing error results in a reduction of A to 10^3, what closed-loop gain results? What is the percentage change in A_f corresponding to this factor of 10 reduction in A?

2. Consider the op amp circuit shown in the figure, where op amp has infinite input resistance and zero output resistance but finite open-loop gain A.
   a) Verify the feedback factor $f = R_1/(R_1 + R_2)$
   b) If $R_1 = 10k\Omega$, find R_2 that results in the closed-loop gain $A_f = 10V/V$ for the following three cases: (i) $A = 1000V/V$; (ii) $A = 100V/V$; (iii) $A = 12V/V$.
   c) For each of the three cases in (b), find the percentage change in A_f that results when A decreases by 20%. Comment on the result.



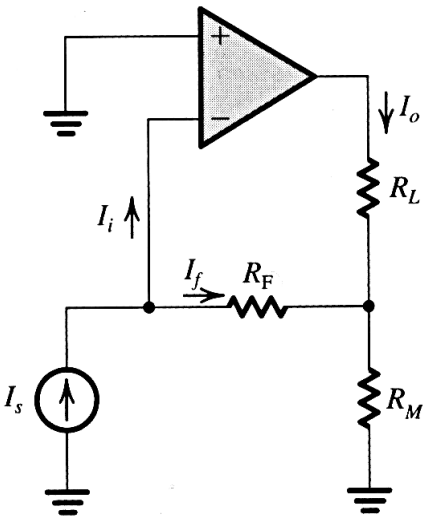
3. The noninverting buffer op amp configuration shown in the figure below (the bottom diagram) is a direct implementation of the feed-back loop of the feedback diagram (the top diagram). Assuming that the op amp has infinite input resistance and zero output resistance, what is the closed-loop voltage gain? What is the amount of feedback (in dB) (the amount of feedback is defined as 1+T)? For $V_s = 1V$, find V_o and V_i. If A decreases by 10%, what is the corresponding percentage decrease in A_f?





4. The feedback current amplifier in the figure utilizes an op amp with an input differential resistance R_{id}, an open-loop gain μ, and an output resistance r_o. The output current I_o that is delivered to the load resistance R_L is sensed by the feedback network composed of the two resistances R_M and R_F, and a fraction I_f is fed back to the amplifier input node.

   Assume the loop gain is large, find expressions for, $f \equiv I_f / I_o$, and $A_f \equiv I_o / I_s$, assuming that the feedback causes the voltage at the input node to be near ground (i.e. it is a virtual ground). For $R_M = 100\Omega$, and $R_F = 10k\Omega$, find f and A_f.



5. Figure below shows a feedback transconductance amplifier utilizing an op amp with open-loop gain μ, very large input resistance, and a very small output resistance, and an NMOS transistor Q. The amplifier delivers its output current to R_L. The feedback network, composed of resistor R, senses the equal current in the source terminal of Q and delivers a proportional voltage V_f to the negative input terminal of the op amp. Assume R is much smaller than the output impedance of Q.
   a) Show that the feedback is negative.
   b) Open the feedback loop by breaking the connection of R to the negative input terminal. Find an expression for $A \equiv I_o / V_i$.
   c) Find an expression for $f \equiv V_f / I_o$.
   d) Find an expression for $A_f \equiv I_o / V_s$.
   e) What is the condition to obtain $I_o \cong V_s / R$