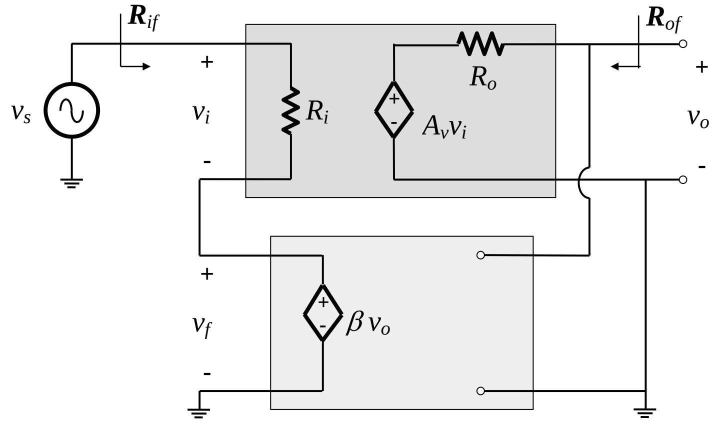
LO-8

To Do the Analysis and Design of Feedback Amplifiers

1. Consider the feedback amplifier given below



$A_{MB} = 10^4$
$\omega_H = 10^4$ rad/sec
$R_i = 100\ k\Omega$
$R_o = 100\ \Omega$
$\beta = 0.01$

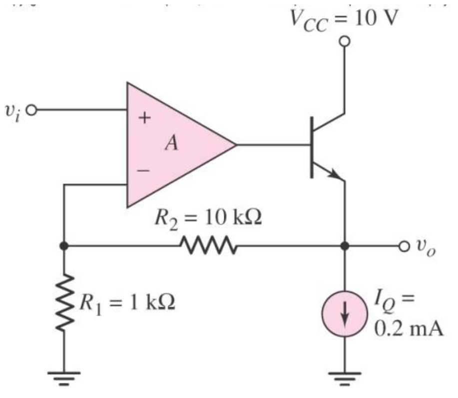
   a) Identify the type of feedback,
   b) Derive the expressions for the closed loop gain $A_{vf} = v_o/v_s$, R_{if} and R_{of}.
   c) Comment on the effect of feedback on the input and output resistances.
   d) Derive the closed loop voltage gain $G_v(j\omega)$ and determine the bandwith, assuming β=0.01, independent of frequency, and

$$A_v(j\omega) = \frac{A_{MB}}{1 + \frac{j\omega}{\omega_H}}$$

   e) Find and compare the gain-bandwith products of the basic amplifier and the feedback amplifier.

2. Considere the feedback amplifier given in Q1. The negative-feedback amplifier has a closed-loop gain of $A_{vf} = 100$ and an open-loop gain $A_v = 10^5$. If a manufacturing error results in a reduction of A_v to 10^3, what closed-loop gain results? What is the percentage change in A_{vf} corresponding to this factor of 100 reduction in A_v?

3. Consider the voltage amplifier given in the figure. The op-amp parameters are:
   $A_v = 5 \times 10^3$, $R_i = 10\ k\Omega$, and $R_o = 1\ k\Omega$.
   and the transistor parameters are
   $\beta = 100$ and $V_A = 80$ V.
   Determine $A_{vf} = v_o/v_s$, R_{if} and R_{of}.

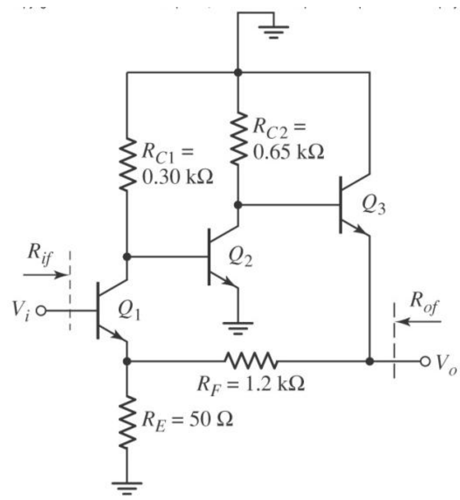


4. The circuit shown on the right is an ac equivalent of circuit of a feedback amplifier.

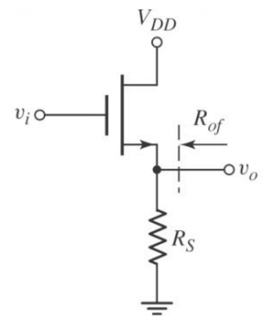
   The transistor parameters are:
   $\beta = 100$ and $V_A = \infty$.

   The quiescent collector currents are:
   $I_{C1} = 14.3$ mA, $I_{C2} = 4.62$ mA, and $I_{C3} = 4.47$ mA.

   (a) Determine the closed loop voltage gain $A_{vf} = v_o/v_s$
   (b) Determine R_{if} and R_{of}.

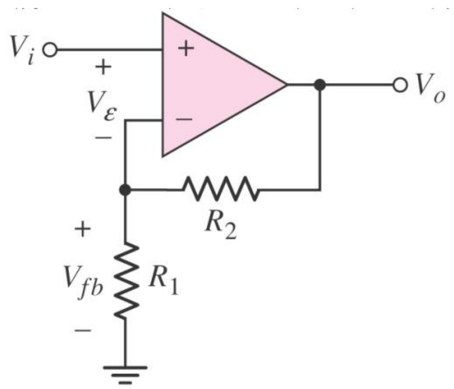


5. A basic source follower is given in the figure. Assume the transistor is biased such that $I_{DQ} = 0.5$ mA and let $R_S = 2$ kΩ. Assume the transistor parameters are:
   $V_{TN} = 1$ V, $\lambda = 0$.
   (a) If the conduction parameter is $K_n = 0.5$ mA/V^2, determine $A_{vf} = v_o/v_s$, and R_{of}.
   (b) Determine the percentage change in A_{vf} and R_{of} if the conduction parameter increases to $K_n = 0.8$ mA/V^2.

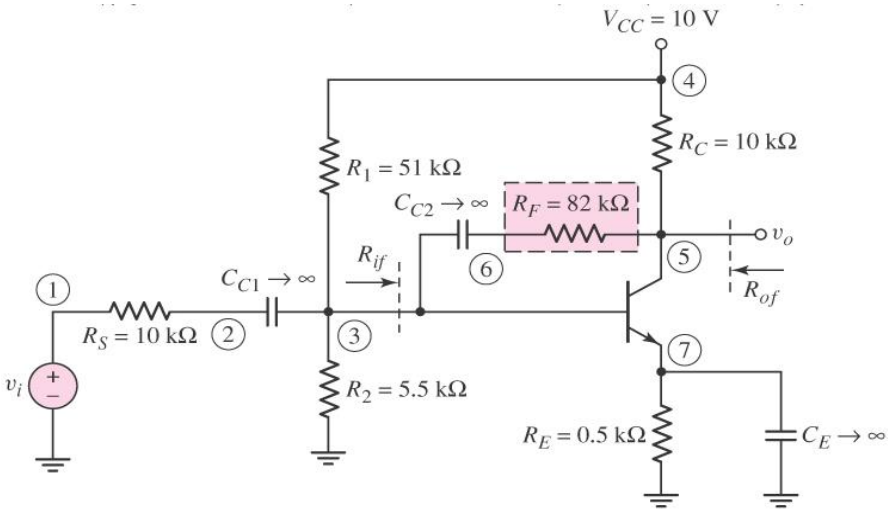


6. Consider the noninverting op-amp in the given figure with $R_i = 50$ kΩ, $R_1 = 10$ kΩ, $R_2 = 90$ kΩ and $A_v = 10^4$.

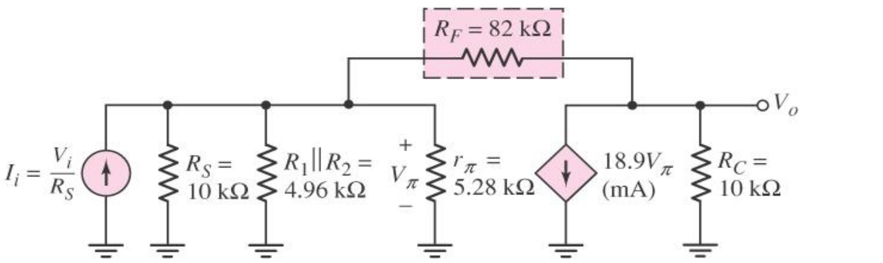
   Determine $A_{vf} = v_o/v_i$, R_{if} and R_{of}.



7. Consider the amplifier given below. Tha tarnsistor parameters are $\beta = 100$, $V_{BE(on)} = 0.7$ V, and $V_A = \infty$. Determine the transresistance and voltage gain.



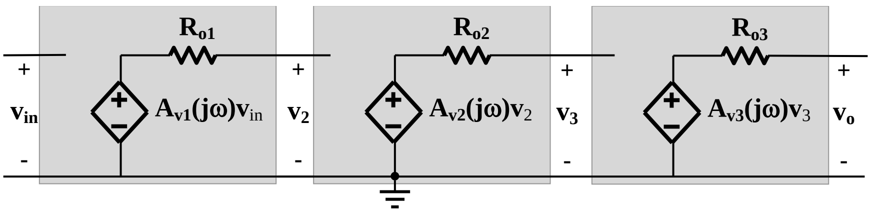
(a)



(b)

8. Determine the voltage gain of the feedback amplifier given in Q7 using Miller's Theorem.

9. Consider the following voltage amplifier having 3 stages.



The voltage gain of the stages are given as follows:

$$A_{v1}(j\omega) = \frac{10}{1 + j(\omega/\omega_1)}; \quad A_{v2}(j\omega) = \frac{100}{1 + j(\omega/\omega_2)}; \quad A_{v3}(j\omega) = \frac{100}{1 + j(\omega/\omega_3)};$$

where $\omega_1 = 10^6$ rad/sec, $\omega_2 = 10^7$ rad/sec, $\omega_3 = 10^9$ rad/sec,

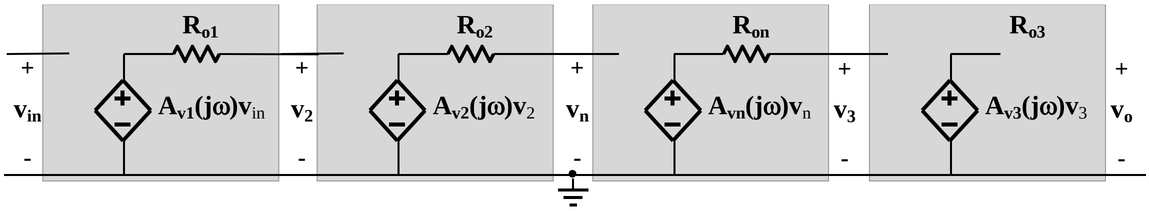
a) Plot the Bode plot of the overall voltage gain

$$A_v(j\omega) = \frac{V_o(j\omega)}{V_{in}(j\omega)}$$

b) Plot the phase of the overall gain as a function of the frequency.
[Hint: For $\omega = 10^8$ rad/sec, $\tan\text{-}1(\omega/10^7) + \tan\text{-}1(\omega/10^9) \cong 90^0$]

c) If the above amplifier is to be used in a feedback circuit having a constant β=0.1, is the overall amplifier stable? Determine the critical frequency ω_C where the amplifier is unstable.

d) The amplifier is modified by adding a new stage as shown below.



The voltage gain of the new stage is

$$A_{vn}(j\omega)=\frac{1+j(\omega/\omega_1)}{1+j(\omega/\omega_1')}$$

For $\omega'_1=10^4$ rad/sec, is the overall feedback amplifier stable?

a) Determine the phase and gain margins of the feedback amplifier (β=0.1) with this new modified amplifier, graphically. [Hint: log(3.16) = 0.5, $\tan^{-1}(3.16) = 72^0$]