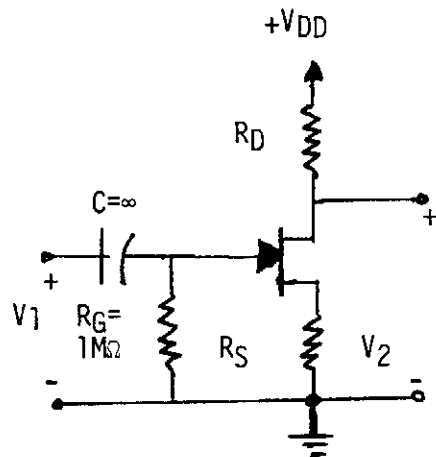


FEEDBACK AMPLIFIER PROBLEMS

- 1.) Use the concepts of negative feedback to design R_D and R_S so that if g_m varies by $\pm 50\%$ that the voltage gain, V_2/V_1 , is equal to $-10 \pm 10\%$. The nominal value of $g_m = 2 \times 10^{-3}$ mhos and r_d is infinite.
(Answer: $R_D = 25$ kilohms and $R_S = 2$ kilohms)

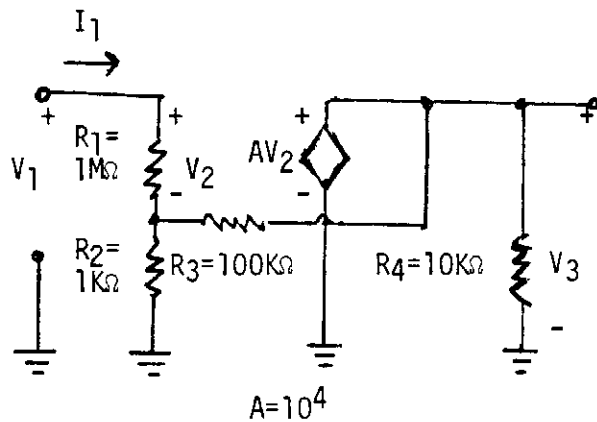


- 2.) A single-loop feedback circuit is shown. Solve for the input resistance defined as

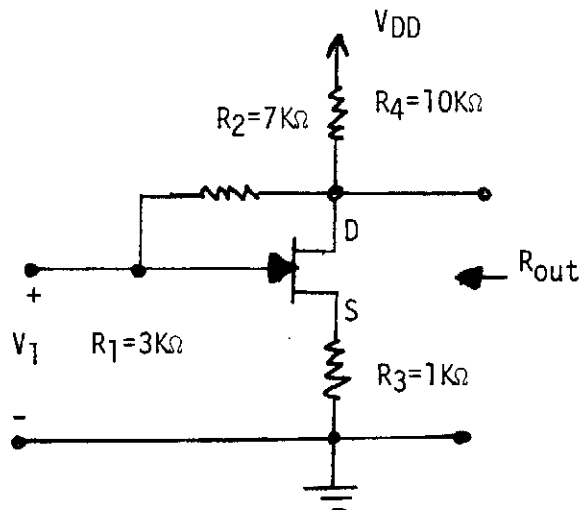
$$R_{in} = V_1/I_1$$

for the element values shown.

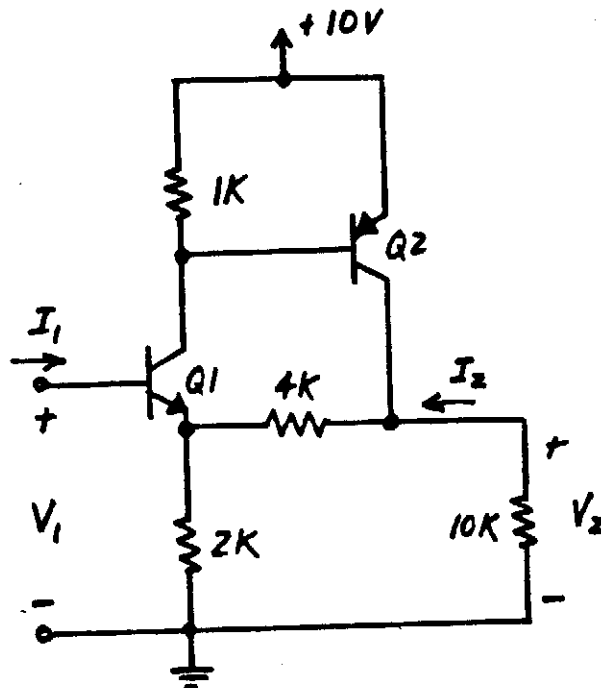
(Answer: $R_{in} \cong 10^9$ ohms)



- 3.) Find the output impedance of the circuit shown where this impedance is designated as R_{out} . Assume that r_d is infinite and that $g_m = 5 \times 10^{-3}$ mhos.
(Answer: $R_{out} = 2.22$ kilohms)

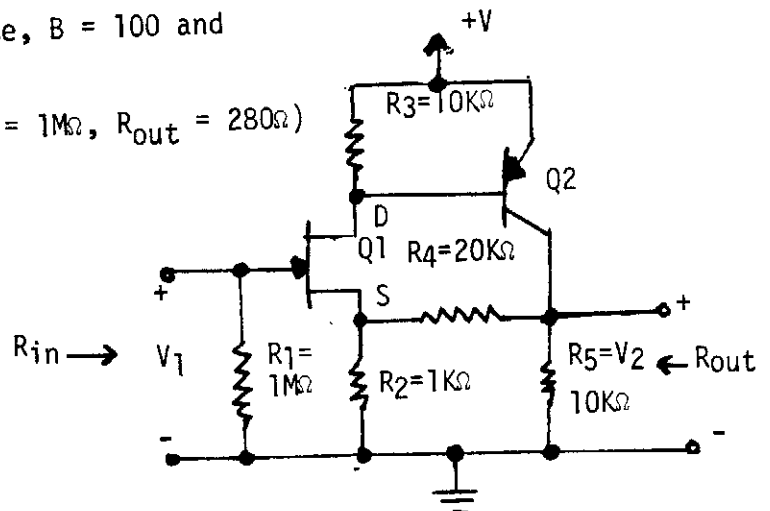


- 4.) A negative feedback circuit is shown below. Use the techniques of feedback analysis to analyze this circuit and find the voltage gain, V_2/V_1 , the current gain, I_2/I_1 , the input resistance, V_1/I_1 , and the output resistance, V_2/I_2 . Assume that $r_{\pi ie} = 1K$ and $B = 100$ for both transistors. Ignore r_o and r_u .
 (Answer: $\frac{V_2}{V_1} = 2.94$, $\frac{I_2}{I_1} = -1874$, $\frac{V_1}{I_1} = 6.376 M\Omega$, $\frac{V_2}{I_2} = 80.43\Omega$)

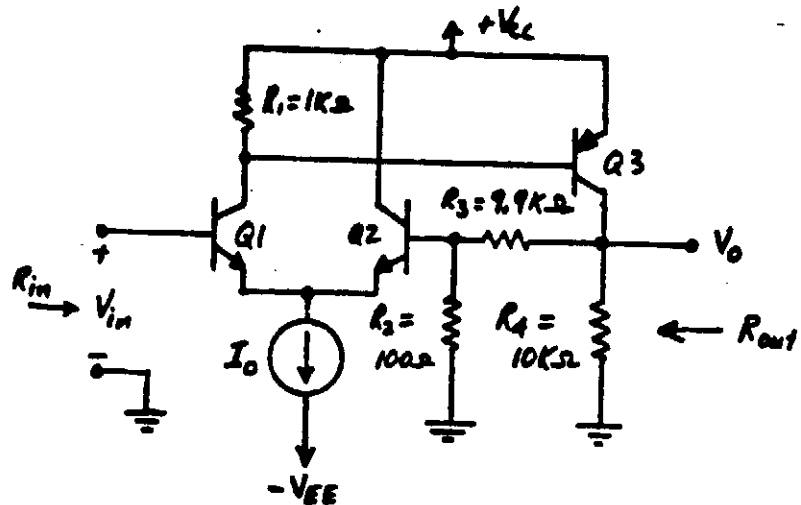


- 5.) Use the methods of opening the feedback loop to find R_{in} , V_2/V_1 , and R_{out} of the circuit shown. Assume the $g_m = 3 \times 10^{-3}$ mhos, r_d is infinite, $B = 100$ and $r_{\pi} = 1000$ ohms.

(Answer: $\frac{V_2}{V_1} = 20.12$, $R_{in} = 1M\Omega$, $R_{out} = 280\Omega$)



- 6.) A feedback amplifier using BJT's is shown below.
- What type of single loop feedback topology is this circuit?
Identify the variables X_s , X_f , X_k , and X_o with regard to their location in the circuit and whether they are voltages or currents.
(Answer: voltage series)
 - Assume that the open loop gain is much greater than unity and find an approximate value for V_o/V_{in} . (Answer: 100)
 - Calculate the voltage gain, V_o/V_{in} , using the methods of opening the feedback loop and calculating A and B. Do not assume that the loop gain is greater than unity. (Answer: 79.67)
 - Calculate R_{in} and R_{out} of this circuit. (Answer: $R_{in}=63.98\text{ K}\Omega$, $R_{out}=164\Omega$)

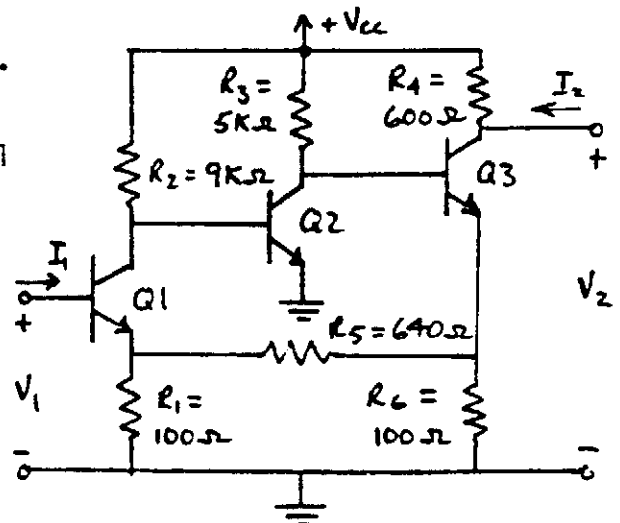


(Answer: $r_{\pi 1}=r_{\pi 2}=r_{\pi 3} = 1\text{K}\Omega$ $B_1=B_2=B_3 = 50$)

- 7.) Use the concepts of feedback analysis to find V_2/V_1 , $V_1/I_1=R_{in}$, and $V_2/I_2=R_{out}$. Do not assume that the open loop gain is much greater than unity. Assume that all transistors are identical with $B=100$ and $r_o=r_u=\infty$ and $I_{C1}=0.6\text{mA}$, $I_{C2}=1\text{mA}$, and $I_{C3}=4\text{mA}$.

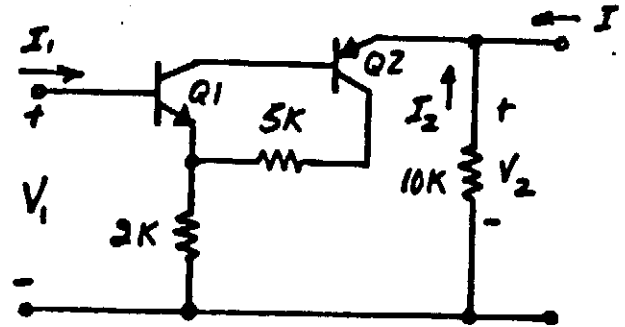
(Answer: $\frac{V_2}{V_1} = 50,21$, $R_{in}=3.187\text{M}\Omega$,

$R_{out} = 600\Omega$)



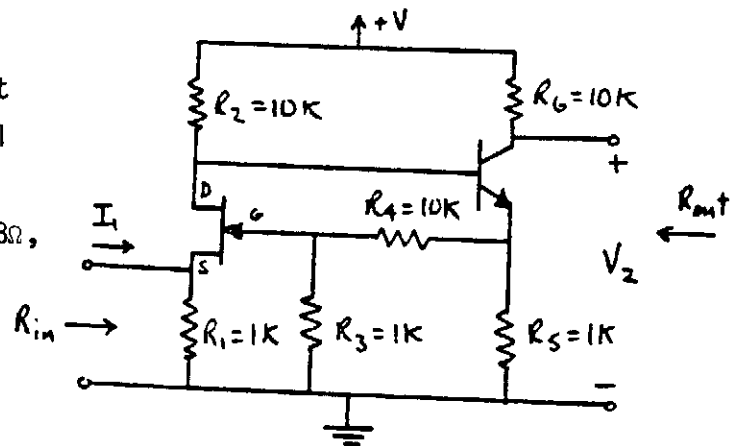
- 8.) A two stage feedback circuit is shown below. Assume that both transistors are identical and have a $\beta=100$ and an $r_{\pi}=1000$ ohms. Use the methods of feedback analysis to find A , A_f , $R_{in}=V_1/I_1$, $R_{out}=V_2/I$, and V_2/V_1 .

(Answer: $A=0.04975$ mhos, $B=2K\Omega$, $A_f=4.95 \times 10^{-4}$ mhos, $R_0=10K$,
 $\frac{V_2}{V_1} = -4.9$, $R_{in} = 20M\Omega$)



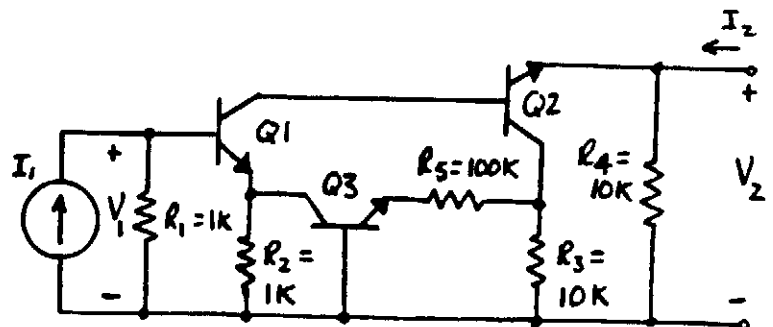
- 9.) A feedback circuit is shown. Do not assume that the loop gain is much greater than unity. Find V_2/I_1 , R_{in} , and R_{out} . Assume that $r_{\pi} = 1000$ ohms, $\beta = 100$, $g_m = .001$ mhos, and $r_d = \infty$.

(Answer: $\frac{V_2}{I_1} = -34,400\Omega$, $R_{in} = 643\Omega$,
 $R_{out} = 10K\Omega$)



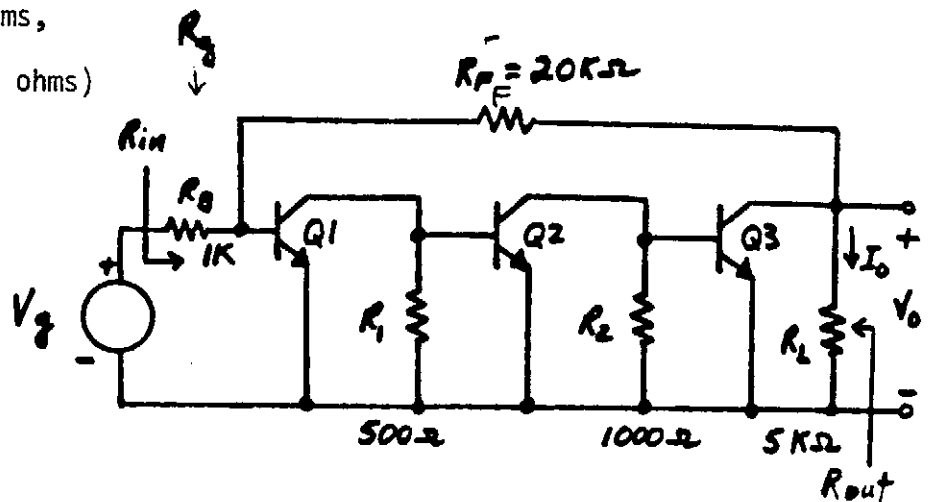
- 10.) A feedback circuit is shown. Do not assume that the loop gain is much greater than unity. Find V_2/V_1 , $R_{in}=V_1/I_1$, and $R_{out}=V_2/I_2$. Assume all transistors are identical and have $\beta = 100$ and $r_{\pi} = 1000$ ohms. (Answer:

$\frac{V_2}{V_1} = 100.79$, $R_{in} \approx 1K\Omega$, $R_{out} = 10K\Omega$)



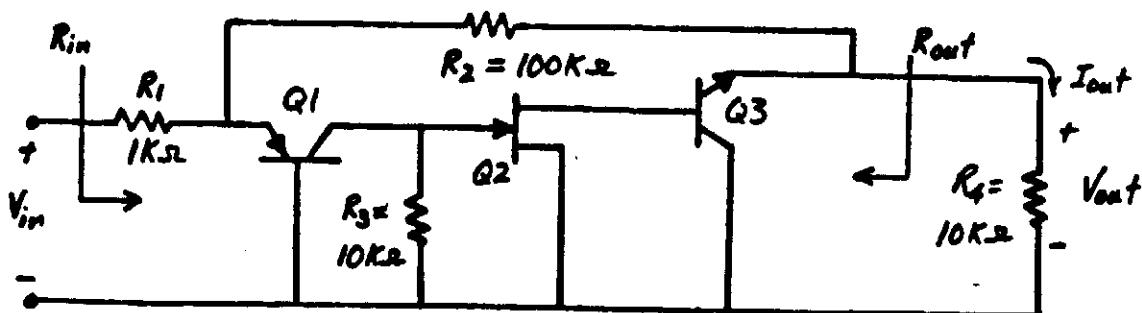
- 11.) For the feedback network shown find V_o/V_g , R_{in} , and R_{out} . Assume that $r_{\pi 1} = r_{\pi 2} = r_{\pi 3} = 1000$ ohms and $B_1 = B_2 = B_3 = 100$.

(Answer: $\frac{V_o}{V_g} = -20.0$, $R_{in} = 1000.03$ ohms, $R_{out} = 0.126$ ohms)



- 12.) A single loop negative feedback circuit is shown. Assume that $B = 100$, $r_{\pi} = 1000$ ohms, and that $r_u = r_o = 0$ for all BJT's and that $g_m = 1 \times 10^{-3}$ mhos and r_d is infinite for the JFET. Do not assume that the loop gain is much greater than one. Use the methods of opening the feedback loop and identify X_s, X_i, X_f , and X_o ; find values for A and B ; and solve for V_{out}/V_{in} , R_{in} , and R_{out} .

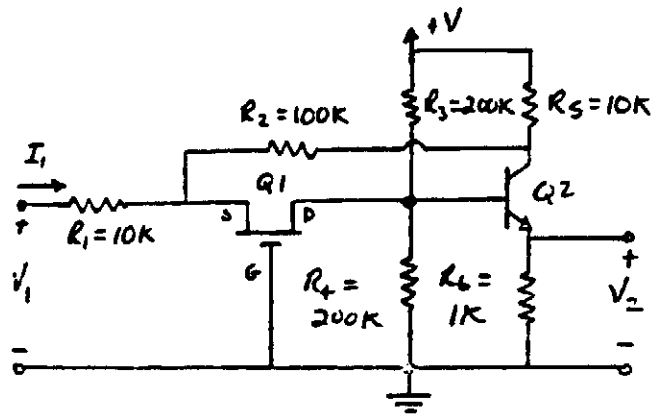
(Answer: $A = 9.09 \times 10^6$ ohms, $B = -10^{-5}$ mhos, $\frac{V_{out}}{V_{in}} = 98.912$, $R_{in} = 1000.1$ ohms, $R_{out} = 98.87$ ohms)



13.) A negative feedback circuit

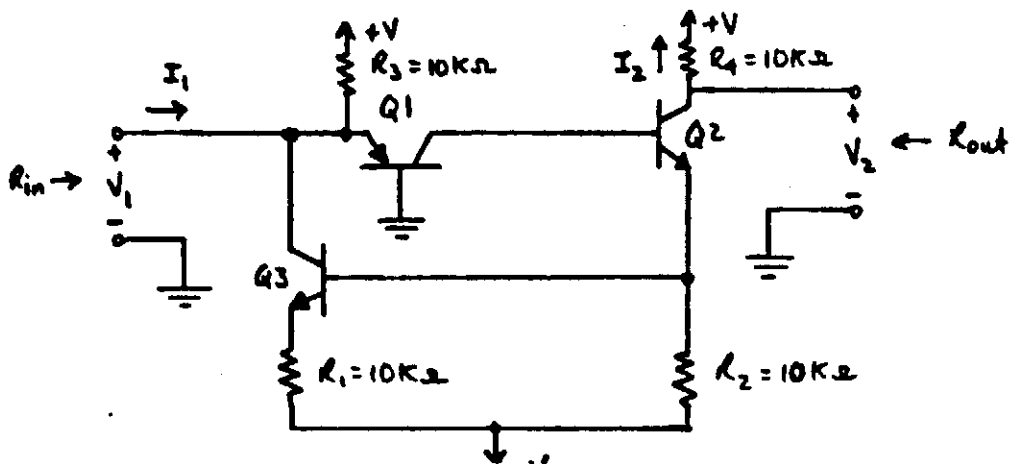
is shown. Do not assume that the loop gain is greater than one and use the methods of opening the loop to calculate a value of V_2/V_1 and $R_{in}=V_1/I_1$. Assume that $B=100$, $r_{\pi}=1000$ ohms, $g_m=10^{-3}$ mhos, and $r_{ds}=\infty$.

(Answer: $\frac{V_2}{V_1} = 5.025$, $R_{in} = 10.187$ ohms)



14.) The negative feedback amplifier shown has the current-shunt topology. Do not assume that $A\beta > 1$ and use the methods of opening the feedback network to calculate A and β and numerically evaluate V_2/V_1 , R_{in} , and R_{out} . Assume both transistors are identical and have $B=100$ and $r_{\pi} = 1000$ ohms.

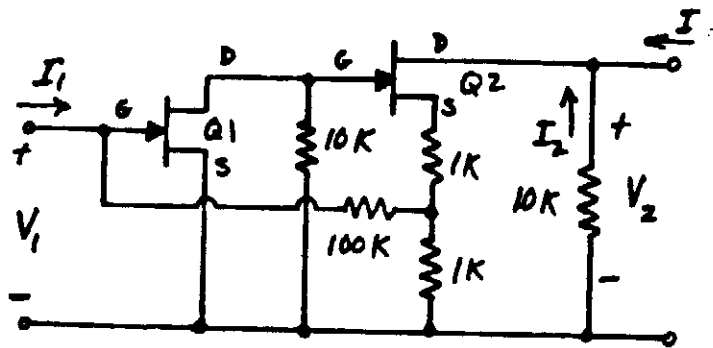
(Answer: $\frac{V_2}{V_1} = 1.0007 \times 10^5$, $R_{in} = 0.1$ ohms, $R_{out} = 10K$ ohms)



- 15.) A two stage feedback circuit is shown below. Assume that both JFET's are identical and have a $g_m = 10^{-3}$ mhos and $r_d = \infty$. Use the methods of feedback analysis to find A , β , A_f , $R_{in} = V_1/I_1$, $R_{out} = V_2/I_2$, & V_2/V_1 .

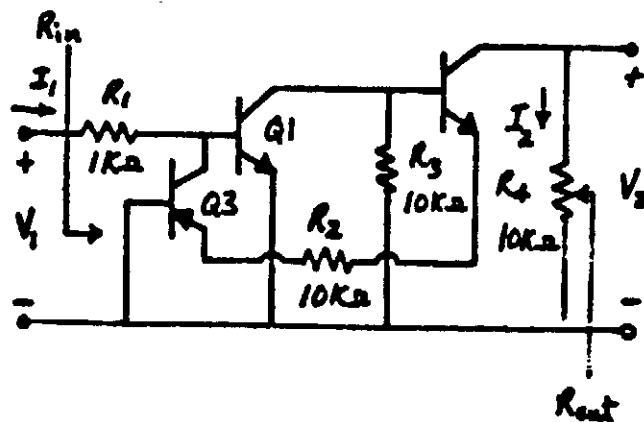
(Answer: $A = -334$, $\beta = -\frac{1}{101}$, $A_f = -77.47$, $\frac{V_2}{V_1} = 33.4$,

$R_{in} = 23.29K$ ohms, $R_{out} = 10K$ ohms)

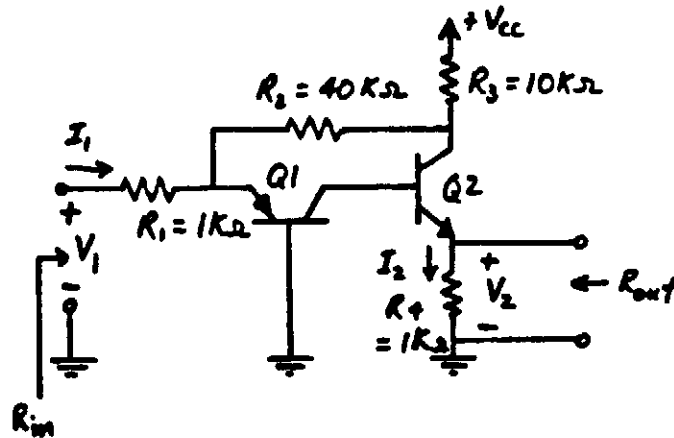


- 16.) In the feedback circuit shown, assume that all the transistors are equal with $\beta = 100$, $r_{\pi} = 1000$ ohms, and $r_u = r_o = \infty$. Do not assume that the loop gain is much greater than unity. Use the techniques of feedback analysis to find V_2/V_1 , R_{in} , and R_{out} .

(Answer: $\frac{V_2}{V_1} = 9.899$, $R_{in} = 1010.1$ ohms, $R_{out} = 10K$ ohms)

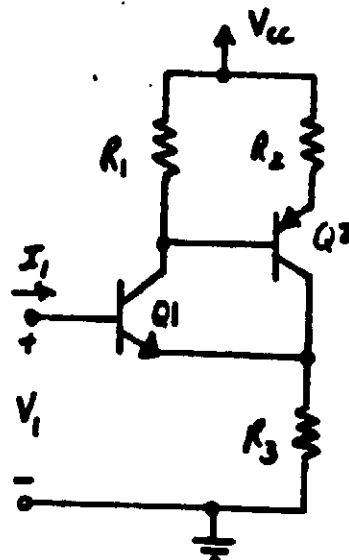


- 17.) For the feedback amplifier shown, find V_2/V_1 , I_2/I_1 , R_{in} , and R_{out} . Assume that Q1 and Q2 are identical with small signal parameters of $r_{\pi}=1000$ ohms and $\beta=100$. Do not assume that $|AB| \gg 1$.
(Answer: $\frac{V_2}{V_1} = 4.805$, $R_{in} = 1000.476$ ohms, $R_{out} = 1K$ ohms)



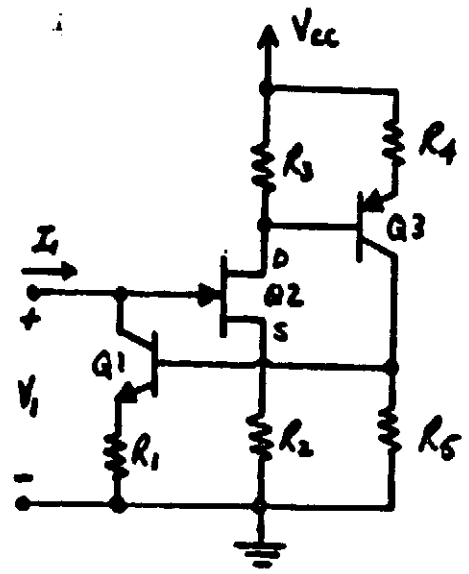
- 18.) For the circuit shown, assume that the β 's of all BJT's and the g_m of all JFET's are very large, approaching infinity. Assume further that h_{ie} 's are zero and that r_d is infinite. Identify the topology, label the variables X_s , X_i , X_f , and X_o where X is a voltage or current, and find the approximate gain if a.) R_2 is the load resistor and b.) R_3 is the load resistor.

(Answer: a.) $\frac{I_o}{V_1} \approx \frac{1}{R_3}$, b.) $\frac{V_o}{V_1} \approx 1$)



- 19.) For the circuit shown, assume that the β of all BJT's and the g_m of all JFET's are very large, approaching infinity. Assume further that r_{π} 's are zero and that r_d is infinite. Identify the topology, label the variables X_s , X_i , X_f , and X_o where X is a voltage or current, and find the approximate gain if a.) R_4 is the load resistor and b.) R_5 is the load resistor.

(Answer: a.) $\frac{I_o}{I_i} \approx \frac{R_1}{R_5}$, b.) $\frac{V_o}{V_i} \approx R_1$)



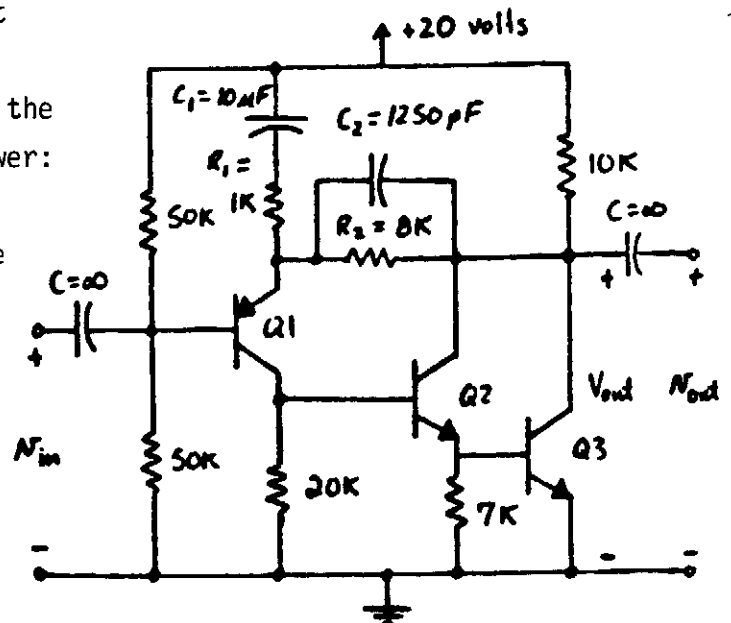
- 20.) A negative feedback circuit is shown. You are to use the assumption that $A\beta \gg 1$.

1. Find the approximate value of the DC output voltage, $V_{out}(DC)$. (Answer: 11.3V)

2. Find the approximate AC voltage gain, v_{out}/v_{in} . (Answer: 9)

3. Give an estimate of the open loop forward gain of this circuit if all the transistors have an $\beta = 100$. (Answer: $A \approx 6230$)

4. If $1/(R_1 C_1) \ll 1/(R_2 C_2)$, find the lower -3dB frequency and the



upper -3dB frequency. (Answer: $f_{-3dB}(\text{lower}) = 15.9 \text{ Hz}$, $f_{-3dB}(\text{upper}) = 15.9 \text{ kHz}$)