10.1 This problem deals with the series–shunt feedback amplifier of Fig. 1. The current-mirror loaded differential amplifier has a feedback network consisting of the voltage divider R1, R2, with R1 + R2 = 1 MΩ. The devices are sized to operate at $|V_{OV}|$= 0.2 V. For all devices, |VA|= 10 V. The input signal source has a zero-dc component.

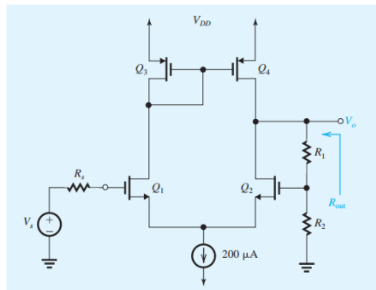

Figure 1

(a) Show that the feedback is negative.

(b) What do you expect the dc voltage at the gate of Q_2 to be? At the output? (Neglect the Early effect.)

(c) Find the A circuit. Derive an expression for A and find its value.

(d) Select values for R1 and R2 to obtain a closed-loop voltage gain Vo/Vs = 5 V/V.

(e) Find the value of R_{out}.

(f) Utilizing the open-circuit closed-loop gain (5 V/V) and the value of R out found in (e), find the value of gain obtained when a resistance R_L = 10 k is connected to the output.

(g) As an alternative approach to (f) above, redo the analysis of the A circuit including R_L. Then utilize the values of R_1 and R_2 found in (d) to determine β and A_f . the value of A_f to that found in (f).

10.2

Figure 2 shows a three-stage feedback amplifier:

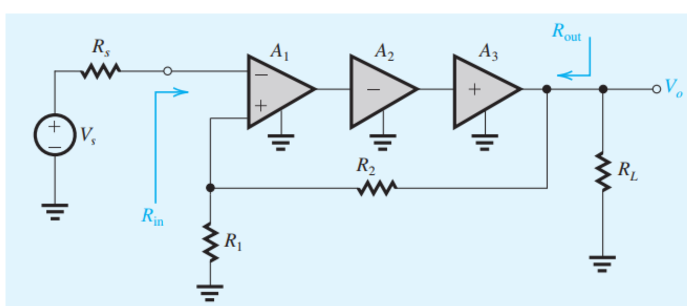

Figure 2

A1 has an 82-kΩ differential input resistance, a 20-V/V open-circuit differential voltage gain, and a 3.2-kΩ output resistance.

A2 has a 5-kΩ input resistance, a 20-mA/V short-circuit transconductance, and a 20-kΩ output resistance.

A3 has a 20-kΩ input resistance, unity open-circuit voltage gain, and a 1-kΩ output resistance. The feedback amplifier feeds a 1-kΩ load resistance and is fed by a signal source with a 9-kΩ resistance.

(a) Show that the feedback is negative.

(b) If R1 = 20 kΩ, find the value of R2 that results in a closed-loop gain Vo/Vs that is ideally 5 V/V.

(c) Supply the small-signal equivalent circuit.

(d) Sketch the A circuit and determine A.

(e) Find β and the amount of feedback.

(f) Find the closed-loop gain Af ≡ Vo/Vs.

(g) Find the feedback amplifier’s input resistance Rin.

(h) Find the feedback amplifier’s output resistance Rout.

(i) If the high-frequency response of the open-loop gain A is dominated by a pole at 100 Hz, what is the upper 3-dB frequency of the closed-loop gain?

(j) If for some reason A1 drops to half its nominal value, what is the percentage change in Af ?