1. Figure P1 shows an IC MOS amplifier formed by cascading two common-source stage. Assuming the biasing current source have very high output resistance, find an expression for the overall voltage gain in terms of g_m and r_o of Q_1 and Q_2. (10%)

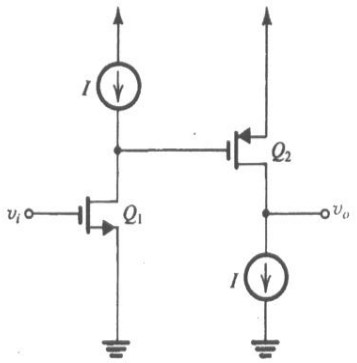


Fig. P1

2. Consider the basic differential circuit in which the transistors have β=200 and V_A=200 V, with I=0.5 mA, R=1 MΩ, and R_C=20 kΩ. Find (20%)
   (a) the differential gain to a differential output (v_i=v_{b1}-v_{b2}, v_o=v_{c2}-v_{c1}),
   (b) the differential input resistance,
   (c) the common-mode gain to a single-ended output, and
   (d) the common-mode input resistance (neglecting the effect of r_μ).

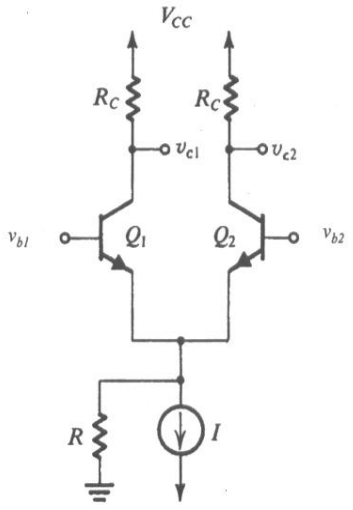


Fig. P2

3. The transistors in the circuit of Fig. P3 have β_0=100, V_A=100 V, C_μ =0.2 pF, and C_{je}=0.8 pF. At a bias current of 100 μA, f_T=400 MHz: (20%)
   (a) Find R_{in} and the midband gain.
   (b) Find an estimate of the upper 3-dB frequency f_H. Which capacitor dominants? Which one is the second most significant?

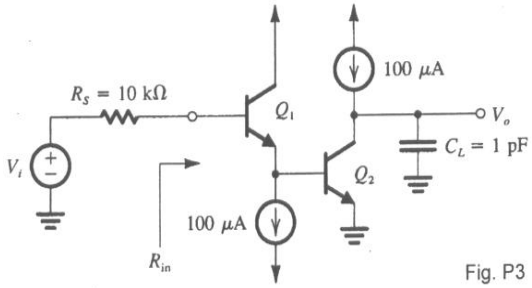


Fig. P3

4. A noninverting buffer op amp configuration is shown below. Assuming that the op amp has infinite input resistance and zero output resistance, the open-loop gain A=99, and V_s=10 V. (20%)
   (a) What is the feedback factor β ?
   (b) What is the closed-loop gain?
   (c) What is the amount of feedback in dB?
   (d) Find V_o and V_i.
   (e) If A decreases by 20%, what is the corresponding decrease in the closed-loop gain?

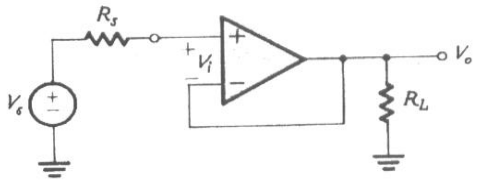


Fig. P4

5. A circuit consisting of a BJT is shown below. Assume the common-emitter current gain β =100, R_C=6 kΩ, R_{B1}=500 kΩ, R_{B2}=2 MΩ. Find the current, ic, that enters the collector and the voltage drop, V_{CE}, between the collector and the emitter. (20%)

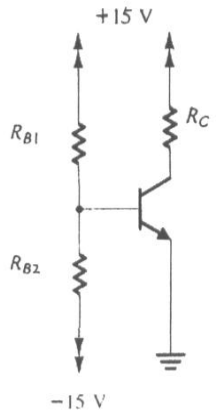
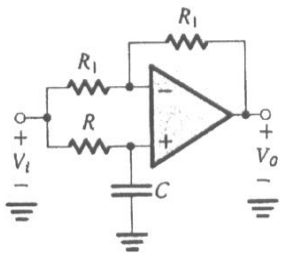


Fig. P5

6. Show that by interchanging R and C in the op amp-RC circuit below, the resulting phase shift covers the range 0 to 180 degree (with 0 degree at high frequencies and 180 degree at low frequencies). (10%)



$CR = 1/\omega_0$
Flat gain $(a_1) = 1$

Fig. P6