1. The circuit of Fig. 1 is a phase-shifting circuit. Assume that the OP Amp is ideal.
   (a) Derive the transfer function of this phase-shifting circuit. (10%)
   (b) Please Find R_i in Fig. 1 so that V_o will lag E_i by 90^0. The frequency of E_i is 1 kHz. (5%)

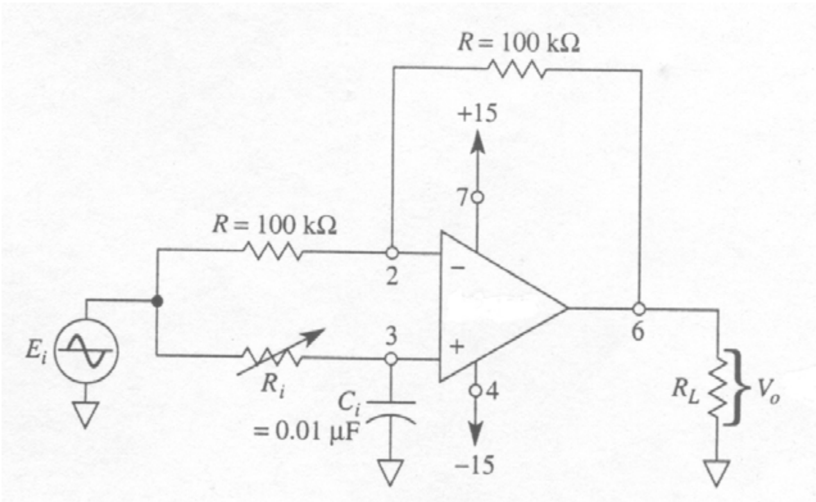

Fig. 1

2. The circuit of Fig. 2 is an adder-subtracter. Assume that the OP Amp is ideal. Please find R_x in Fig. 2 so that its output is $V_{out} = -4V_1 - 2V_2 + 10V_3 + V_4$. (15%)

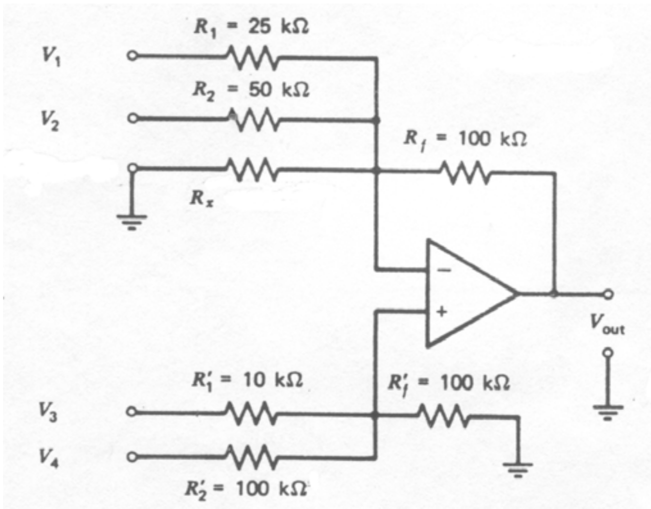

Fig. 2

3. A BJT with β=100 is used in Fig. 3 with the voltage V_{BE} = 0.7V.

   (a) Determine the dc current I_{CQ} and the dc voltage V_E of the BJT. (5%)

   (b) Sketch the small signal equivalent circuit. (5%)

   (c) Find the voltage gain v_o / v_s and the input resistance R_{in}. (15%)

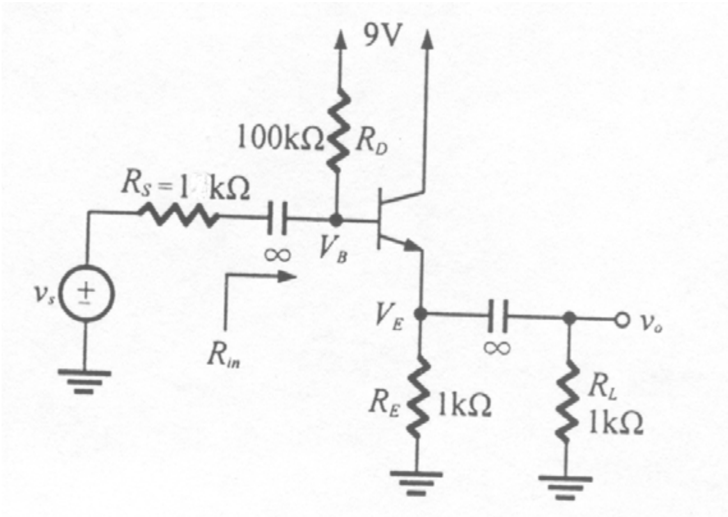

Fig. 3

4. For the circuit shown in Fig. 4, assume high β and BJTs having V_{BE} = 0.7V at 1mA.

   (a) Find the value of R that will result in I_o=10μA. (10%)

   (b) For the design in (a) find the output resistance R_o, assuming β=100, V_A = 100V and V_T = 25 mV. (10%)

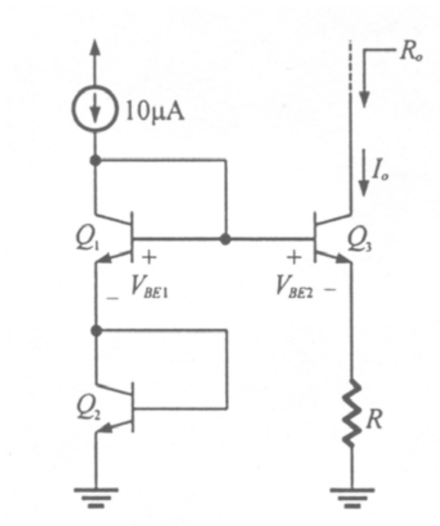

Fig. 4

5. For the circuit shown in Fig. 5, determine the small-signal voltage gain, $A_v = v_o / v_i$. Assume transistor parameters of V_{TN} = 1V, K_n = 0.2 mA/V^2, and λ =0 for M_1 and β =80 and V_A = ∞ for Q_1.(15%)

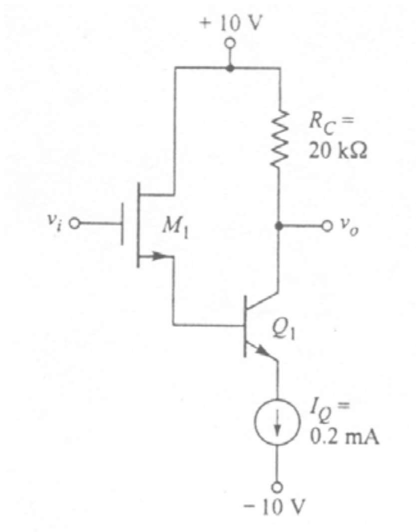

Fig. 5

6. For the circuit shown in Fig. 6, assume that the OP-AMPs are ideal. Determine the values of R_1 and R_2 so that the circuit will operate as a full-wave rectifier with a gain of 5. (10%)

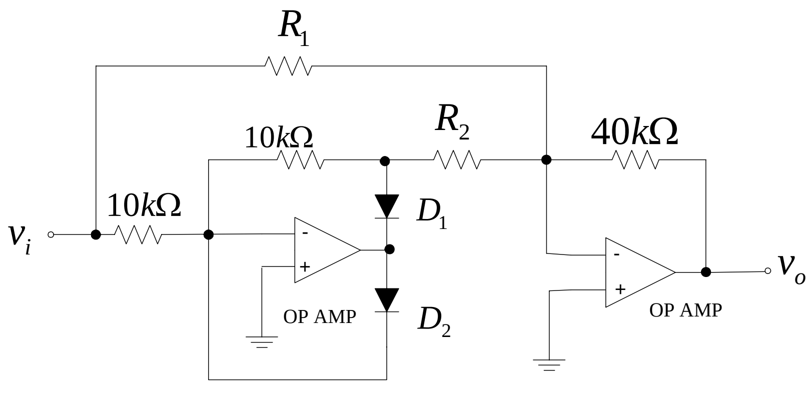

Fig. 6