1. In Fig. 1 the diode has a voltage drop $V_D = 0.8V$.
   (a) Use Thevenin's theorem to simplify the circuit and, [5%]
   (b) hence calculate the diode current I_D. [5%]

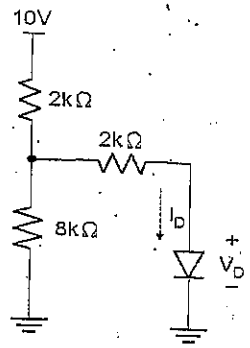

Fig. 1

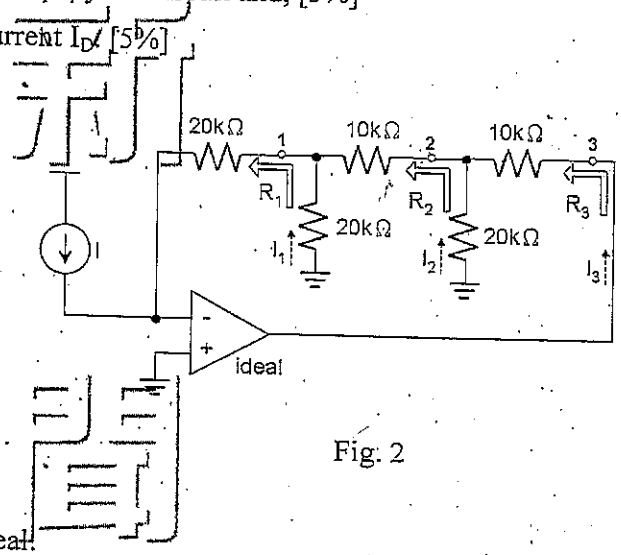

Fig. 2

2. The OP amplifier in Fig. 2 is ideal.
   (a) What are the characteristics of an ideal OP amplifier? [5%]
   (b) Find the resistances looking into node 1, R_1; node 2, R_2; and node 3, R_3. [5%]
   (c) Find the current I_1, I_2, and I_3 in terms of the input current I. [5%]

3. In Fig. 3, assume $V_{id} = V_2 - V_1$, find the differential voltage gains of A_m and A_o, where $A_m = V_m/V_{id}$, $A_o = V_o/V_{id}$. [20%]

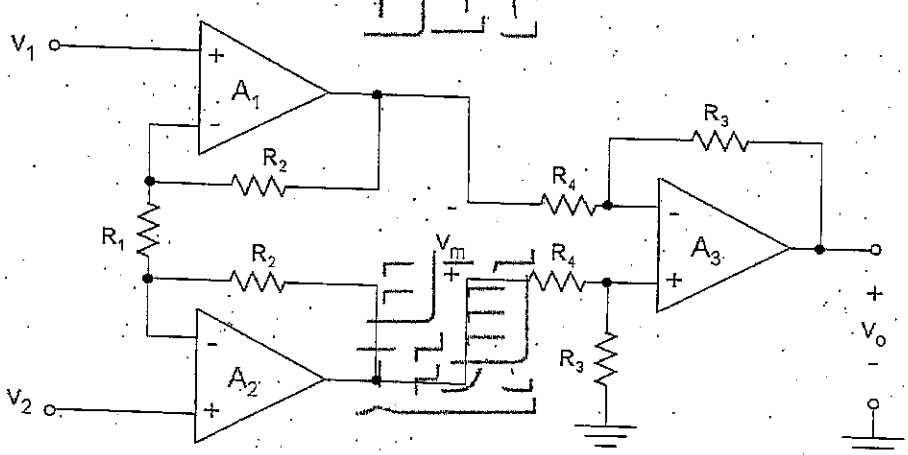

Fig. 3

4. In Fig. 4, assume all of the transistors are operating in saturation. Derive I_{copy} for the following two circuits. [10%]

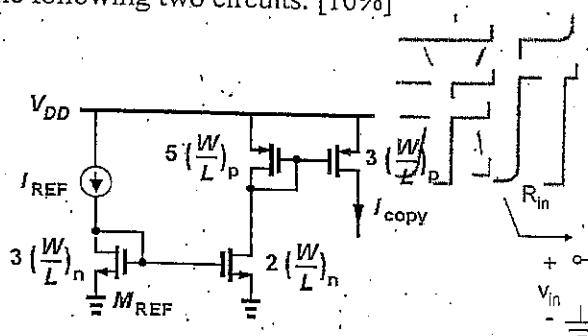

Fig. 4

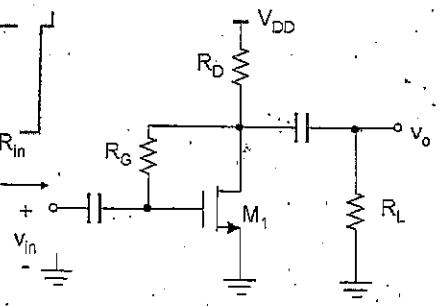

Fig. 5

5. In Fig. 5, assume the capacitors to be sufficiently large so as to act as short circuit at the signal frequencies of interest. $V_{DD} = 2V$, $R_G = 10M\Omega$, $R_D = 5K\Omega$, $R_L = 5K\Omega$, M_1 has $V_t = 1$ V, $k'_n(W/L) = 0.4$ mA/V^2, and $V_A = 40$ V. Find
   (a) the dc operating point, [5%]
   (b) the small-signal equivalent circuit, [5%]
   (c) the voltage gain $A_v = v_o/v_{in}$, [5%]
   (d) and the input resistance R_{in}. [5%]

6. To design a CE stage of Fig. 6 for a voltage gain of 20, what is the minimum allowable supply voltage if Q_1 must remain in the active mode? Assume $V_A = \infty$ and $V_{BE} = 0.8$ V. [10%]

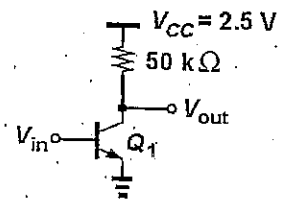

Fig. 6

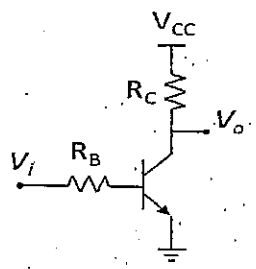

Fig. 7

7. For the circuit in Fig. 7, draw its voltage transfer characteristics, i.e. the plot of V_i vs. V_o. Assume $V_{CC} = 5$V, R_B=10kΩ, R_C=1kΩ, β=50, and $V_{CEsat} = 0.2$V. [10%]

8. Translate the following paragraph into Chinese. [5%]

"CMOS (complementary metal oxide semiconductor) technology is reliable, manufacturable, low power, low cost, and, perhaps most importantly, scalable. The fact that silicon integrated circuit technology is scalable was observed and described in 1965 by Intel founder Gordon Moore. His observations are now referred to as Moore's law and state that the number of transistors on a chip will double every 18 months."