請按題號順序作答 (每題分數 20 分)

1. In the circuit of Fig. 1, the NMOS transistor has $|V_t| = 0.9$ V and $V_A = 50$ V, and operates with $V_O = 2$ V.
   (a) What is the voltage gain v_o / v_i?
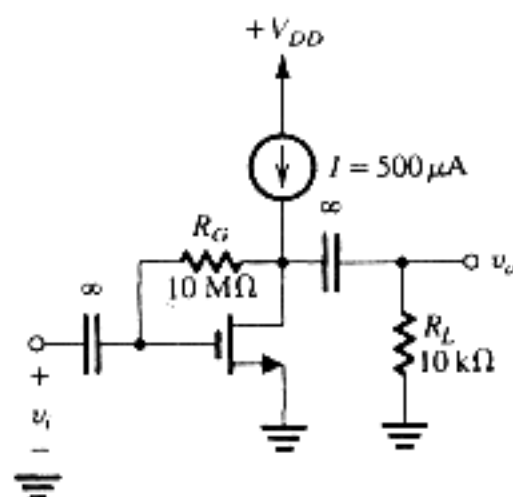   (b) What do V_O and the gain become for I increased to 1 mA?

2. For the differential amplifier shown in Fig. 2, find
   (a) the differential gain,
   (b) the differential input resistance,
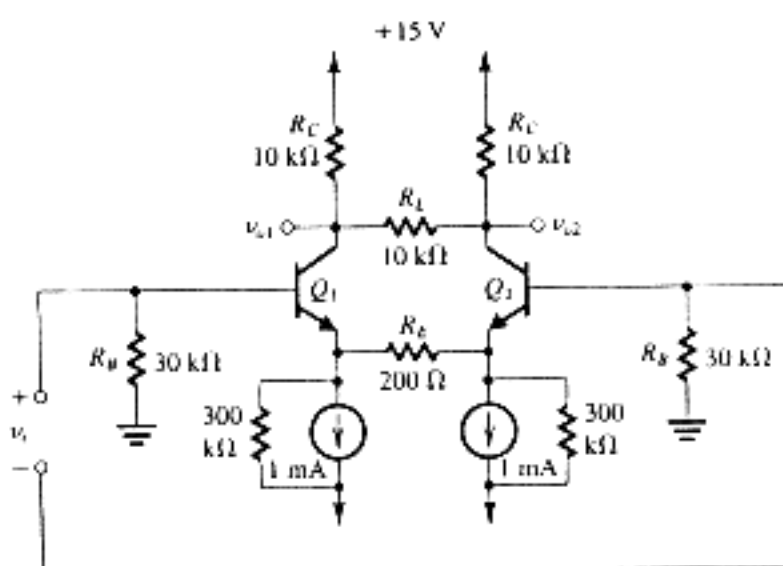   (c) the common-mode gain, and
   (d) the common-mode input resistance.

3. A class AB output stage using a two-diode bias network as shown in Fig. 3 utilizes diodes having the same junction area as the output transistors. For $V_{CC} = 10$ V, $I_{bias} = 0.5$ mA, $R_L = 100 \, \Omega$, $\beta_N = 50$, and $|V_{CEsat}| = 0$ V, what is the quiescent current? What are the largest possible positive and negative output signal levels? To achieve a positive peak output level equal to the negative peak level, what value of β_N is needed if I_{bias} is not changed? What value of I_{bias} is needed if β_N is held at 50?

4. For the circuits in Figs. 4(a) to 4(c), sketch and label the transfer characteristic $v_O - v_I$. Denoting the zener voltages of Z_1 and Z_2 by $V_{Z1} = 6$ V and $V_{Z2} = 4$ V and assuming that in the forward direction the voltage drop is approximately 0.7 V. The diodes are assumed to have a constant 0.7 V drop when conducting. The op amp saturates at ± 12 V.

5. Design a Chebyshev filter that meets the following low-pass specifications: $f_p = 3.4$ kHz, $f_s = 4$ kHz, $A_{max} = 1$ dB, and $A_{min} = 35$ dB Find the required order N, the poles, and the transfer function $T(s)$.
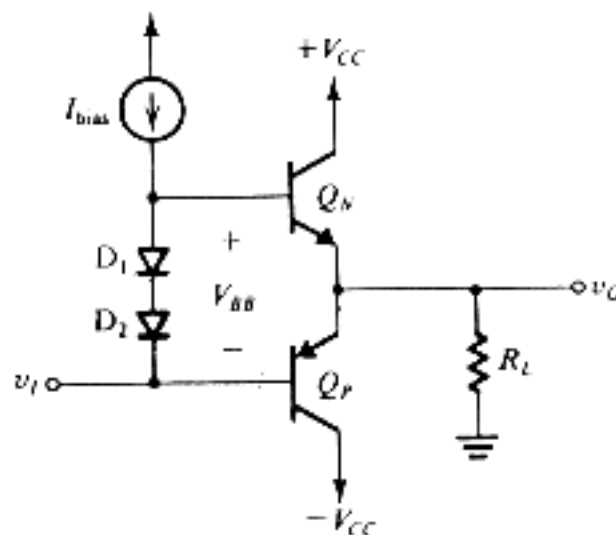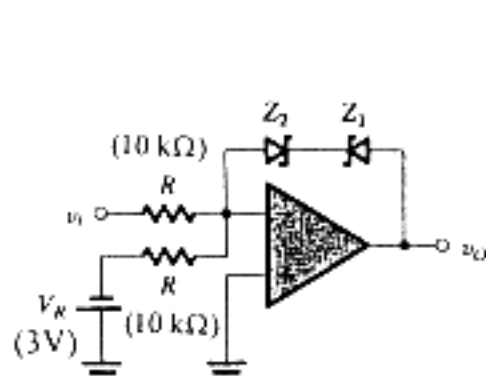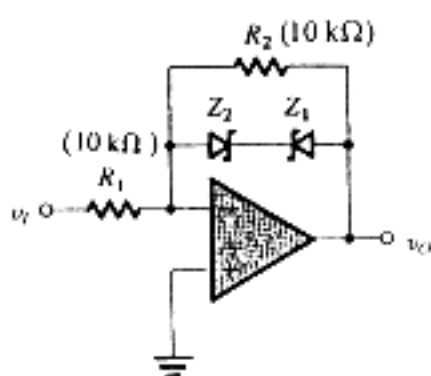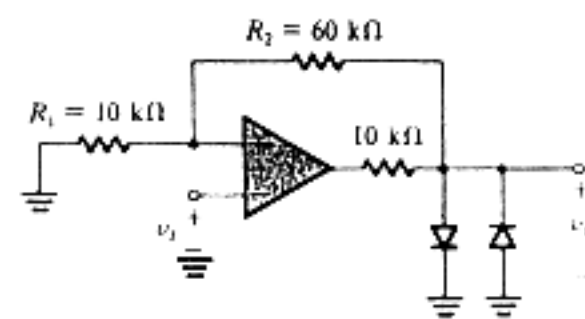

Fig. 1

Fig. 2

Fig. 3

Fig.4(a)　　　　　Fig. 4(b)　　　　　Fig. 4(c)