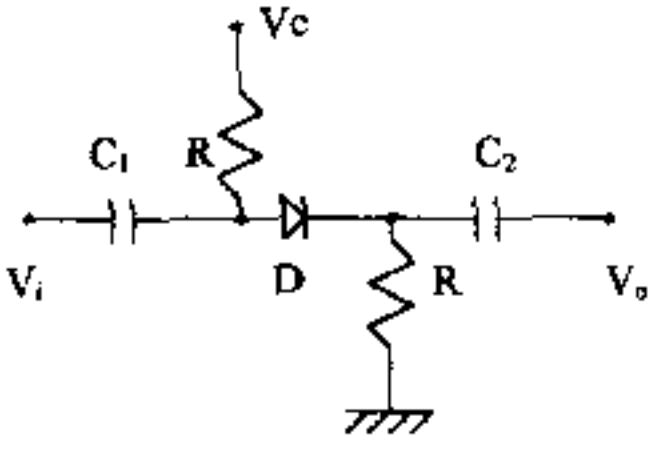
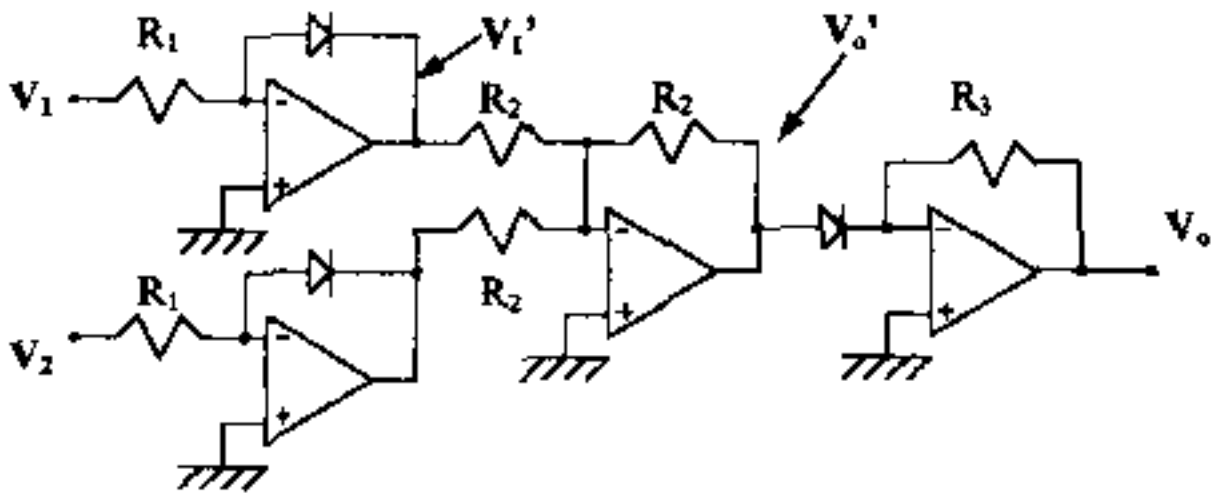
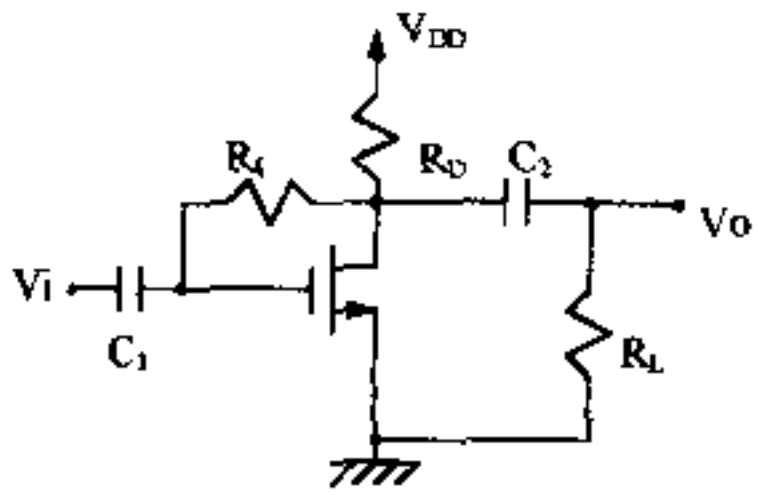
1. In the circuit, the capacitors are $C_1=C_2=\infty$. The diode has a cut-in voltage V_D and I-V characteristics of $I_D=I_s\exp(V_D/V_T)$. The input V_i is a small ac signal. The control voltage Vc is a variable dc voltage.
   (a) Sketch the small-signal equivalent circuit.
   (b) Find the output voltage V_o as function of Vc.
   (8%)



2. In the circuit, the op-amps are ideal and the diodes are characterized by $I_D=I_s\exp(V_D/V_T)$. The voltages V_1 and V_2 are positive. Find the voltages V_1', V_o' and V_o.
   (12%)



3. In the circuit, the capacitors are assumed $C_1=C_2=\infty$. The MOSFET has given k and Vt values.
   (a) Find R_D such that $V_{DS}=V_{DD}/2$.
   (b) Sketch the small signal equivalent circuit and find the voltage gain Vo/Vi.
   (12%)

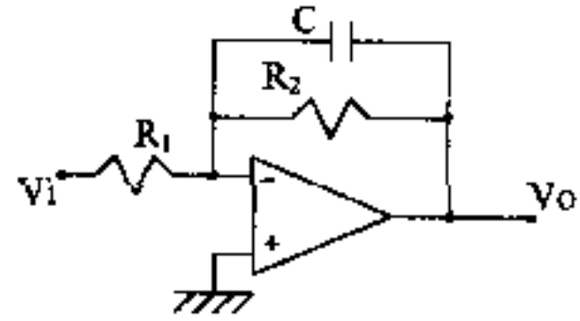


4 For the circuit shown, the op-amp is ideal.

(a) Find the dc gain and the 3-dB frequency.

(b) Design the values of resistors and capacitor so as to obtain an input resistance of 2 kΩ, a dc gain of 40 dB, and a 3-dB frequency of 4 kHz. What is the unity-gain bandwidth f_T?

(10%)



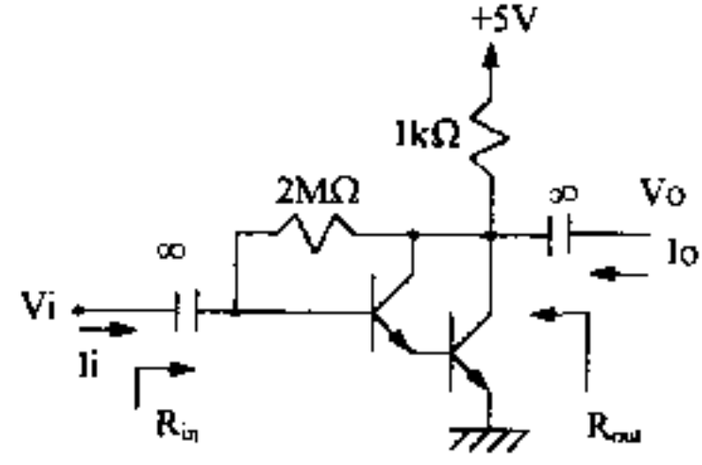
5. For the circuit shown,

(a) perform its DC analysis,

(b) sketch its small-signal equivalent circuit,

(c) calculate the open-circuit voltage gain, the short-circuit current gain, the input resistance, and the output resistance. Note that the β of the transistors is equal to 100.

(23%)



6. For the function of $Y = \overline{AB + CD}$ with inputs A, $\overline{A}$, B, $\overline{B}$, C, $\overline{C}$, D, and $\overline{D}$ available You can take the TTL circuits or ECL circuits as 2-input logic gates.
   (a) Draw the gate-level scheme of open-collector TTL circuit to implement Y You have to show the output connections and pull-up device.
   (b) Draw the transistor -level scheme of a CMOS gate to implement Y.
   (c) Draw the gate-level scheme of ECL wired-function to implement Y.
   (12%)

7. For the second-order band pass transfer function,
   (a) Write down the equation T(S)=?
   (b) Use R, L, C only (one of each) to implement the band pass function. (Draw the circuit)
   (c) Find the center-frequency gain in terms of R, L, and C.
   (d) Find the sensitivity $S_C^{W_0}$, where W_0 means center-frequency.
   (e) Draw the circuit that replaces the R in (b) with the switched-capacitor realization.
   (15%)

8. Using three resistors with values R_1, R_2, R_3, a capacitor with value C and an ideal op amp with saturation voltage L (max.) and -L (Min) to **build** an astable multivibrator that can produce square wave. Also **calculate** the period in terms of R_1, R_2, R_3, C, and L.
   (8%)