國立臺灣大學96學年度碩士班招生考試試題

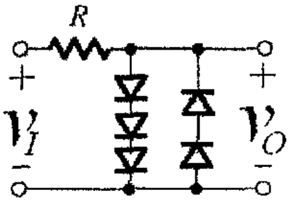
1. Plot the transfer characteristics v_O as a function of v_I for the circuits as shown in Fig. 1(a), (b), (c), and (d). Use the constant-voltage-drop model, i.e. 0.7-V model, for all diodes in the figures. ***(20%)***

2. Assume all op amps are ideal in Fig. 2. ***(20%)***
   (a) Find v_o in Fig. 2, where $R_1 = 10\text{k}\Omega$, $R_2 = 20\text{k}\Omega$, $R_3 = 30\text{k}\Omega$, $R_4 = 40\text{k}\Omega$, $R_5 = 10\text{k}\Omega$, $R_a = 20\text{k}\Omega$, $R_b = 10\text{k}\Omega$, $R_c = 30\text{k}\Omega$, $R_d = 10\text{k}\Omega$, $R_e = 40\text{k}\Omega$.
   (b) Use only two ideal op amps to re-design a weighted summer which has the same function found in (a). The smallest resistor used in this weighted summer should be 10kΩ.

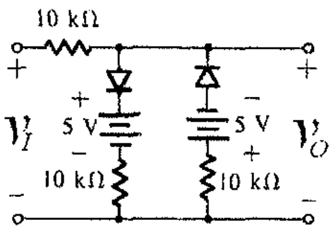
3. Describe the negative feedback action of R_E to stabilize the bias current in Fig. 3 by considering that the emitter current increases for some reason. ***(10%)***

4. Fig. 4 is a typical structure of the enhancement-type NMOS transistor. Assume $W = 0.16\,\mu\text{m}$, $L = 0.13\,\mu\text{m}$, and t =2 nm. The permittivity of the silicon dioxide is $3.9\varepsilon_0$, and $\varepsilon_0 = 8.854\times10^{-12}$ F/m. The overlap length from the extension of the source and drain diffusions under the gate oxide is L_{ov}, and $L_{ov} = 0.05\,L$. ***(30%)***
   (a) Find the approximate gate capacitances, C_{gs}, C_{gd}, and C_{gb} as the MOSFET operates in the triode region for small v_{DS}.
   (b) Find the approximate gate capacitances, C_{gs}, C_{gd}, and C_{gb} as the MOSFET operates in saturation region.
   (c) Find the approximate gate capacitances, C_{gs}, C_{gd}, and C_{gb} as the MOSFET is cut off.
   (d) Write down a brief run sheet and draw the cross sections of important steps to make the NMOS transistor in Fig. 4 from a bulk silicon wafer by standard VLSI fabrication technology.

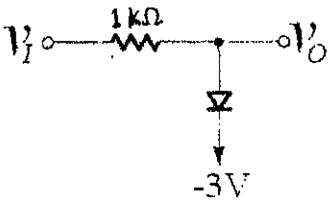
5. The transistors in Fig. 5 have $V_{BE} = 0.7$ V and $\beta = 100$. ***(20%)***
   (a) Do the DC analysis in Fig. 5, and determine which modes do Q_1 and Q_2 operate?
   (b) Find i_c, g_{meq}, v_o/v_i, and R_{in}.



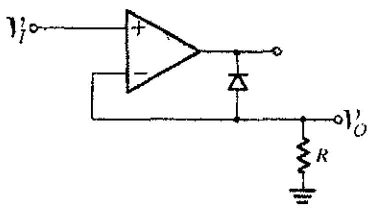
(a)



(b)



(c)



(d)

Fig. 1

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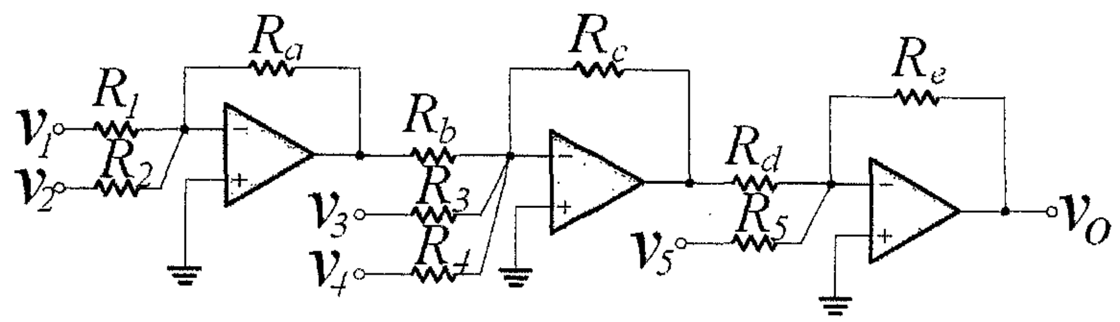

Fig. 2

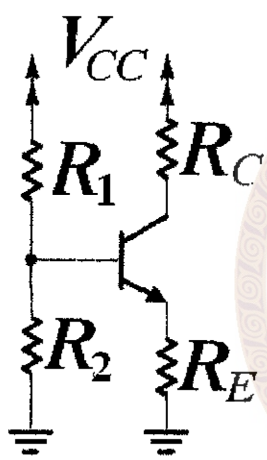

Fig. 3

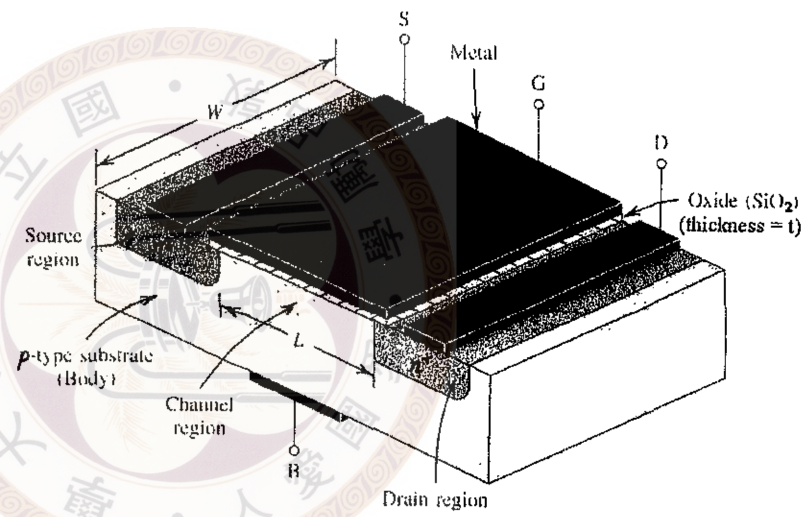

Fig. 4

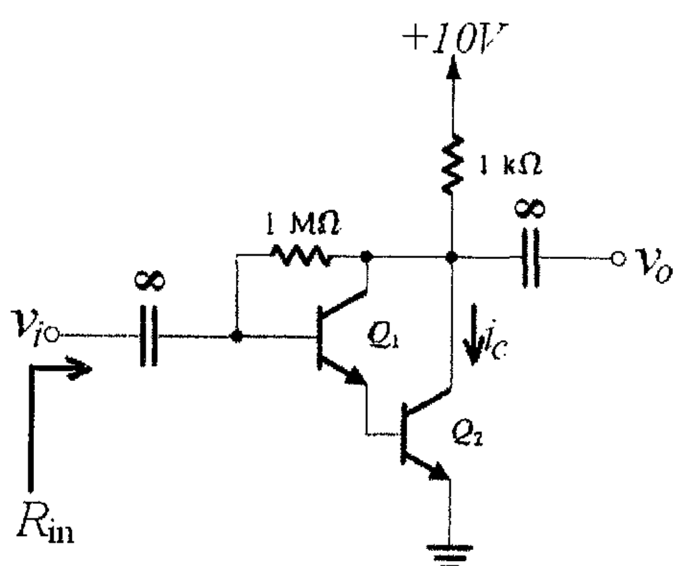

Fig. 5

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