

科目：電子學 適用：電機所電子組

編號：432

考生注意：

1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 限用藍、黑色筆作答；試題須隨卷繳回。

本試題  
共 3 頁  
第 1 頁

1. Use the intrinsic carrier density of  $1.5 \times 10^{10} \text{ cm}^{-3}$  at  $300^\circ \text{K}$ . Consider a p-type silicon with  $N_A = 10^{16} \text{ cm}^{-3}$ . (a) Find the electron and hole concentrations at  $300^\circ \text{K}$ . [5%] (b) Find the resistivity of the doped silicon which has  $\mu_n = 1200 \text{ cm}^2 / \text{Vs}$  and  $\mu_p = 400 \text{ cm}^2 / \text{Vs}$ . [5%]
2. Use English to briefly explain the reasons for CMOS displacing bipolar technology in contemporary digital applications. [10%]
3. In Fig. 1, assume the capacitors to be sufficiently large so as to act as short circuit at the signal frequencies of interest,  $V_{DD} = 7 \text{ V}$ ,  $R_G = 10 \text{ M}\Omega$ ,  $R_D = 5 \text{ K}\Omega$ ,  $R_L = 5 \text{ K}\Omega$ ,  $M_1$  has  $V_t = 1 \text{ V}$ ,  $k'_n (W/L) = 0.4 \text{ mA} / \text{V}^2$ , and  $V_A = 40 \text{ V}$ . 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%]

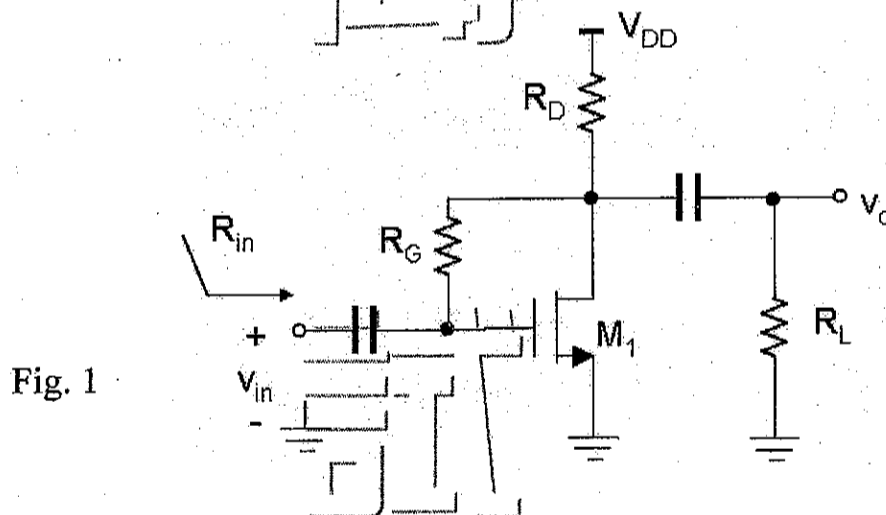


Fig. 1

4. In Fig. 2, draw its equivalent circuit and find the output resistance  $R_o$ , neglecting the body effect in  $M_3$ . [10%]

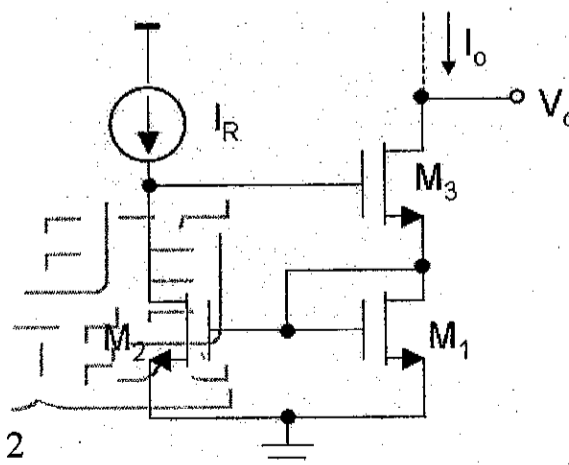


Fig. 2

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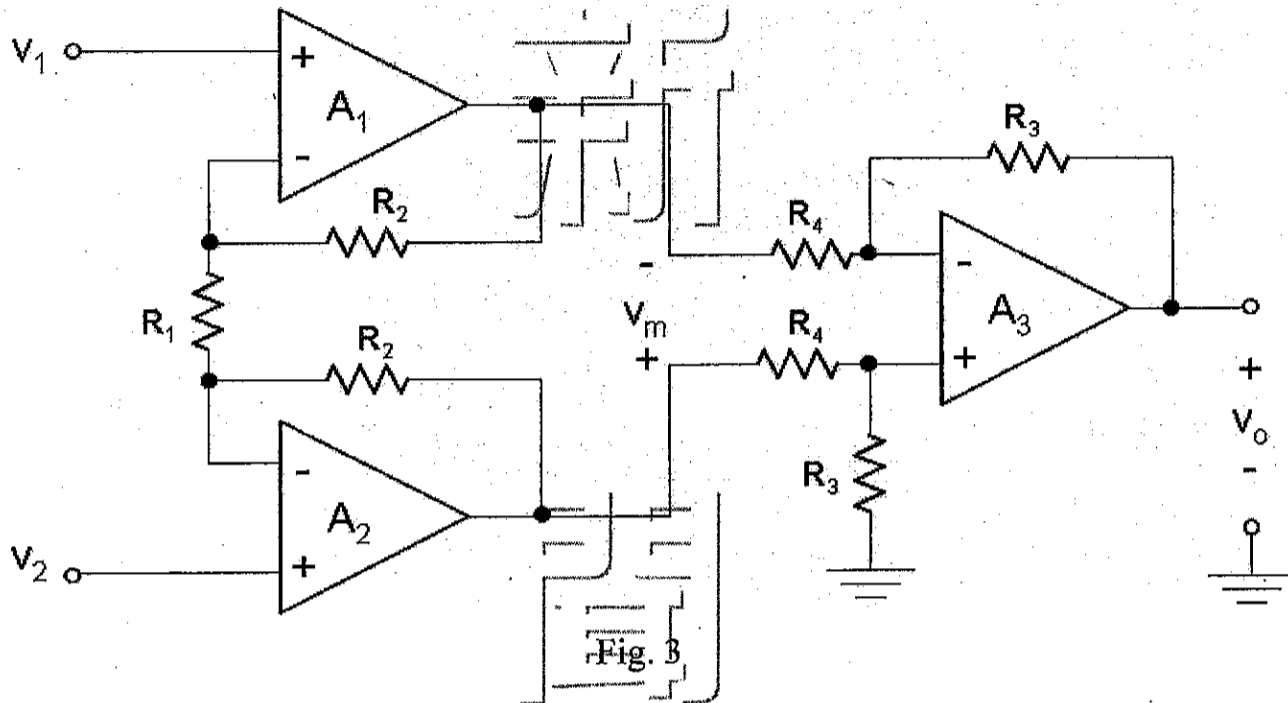
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本試題  
共 3 頁  
第 2 頁

5. In Fig. 3, assume  $v_{id} = v_2 - v_1$ , find the differential voltage gains of  $A_m$  and  $A_o$ , where  $A_m = v_m / v_{id}$ ,  $A_o = v_o / v_{id}$ . [10%]



6. (a) What feedback topology is the circuit in Fig. 4? [5%] (b) Assume the transistors to have  $\beta=100$  and  $V_A = 75$  V. Find  $I_{out} / I_{in}$ ,  $R_{in}$ , and  $R_{out}$ . [15%]

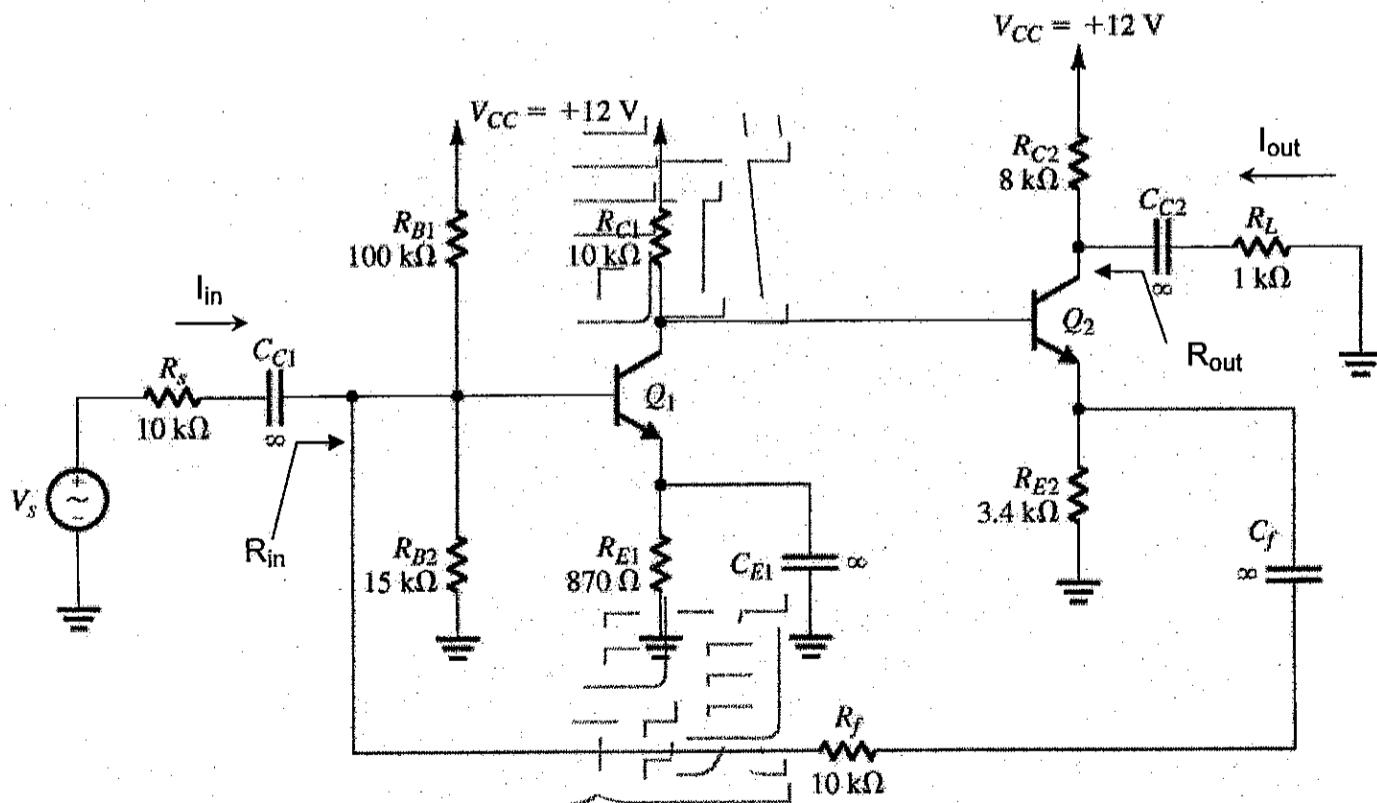


Fig. 4

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本 試 題  
共 3 頁  
第 3 頁

7. Figures 5(a) and 5(b) show a two-stage CMOS op-amp and its equivalent circuit, respectively.  $G_{m1} = g_{m1} = g_{m2}$ ,  $G_{m2} = g_{m6}$ . (a) Find  $R_1$ ,  $R_2$ ,  $C_1$ , and  $C_2$ . [10%]

(b) Also, find the amplifier transfer function  $v_o / v_{id}$ , and its zero and two poles. [10%]

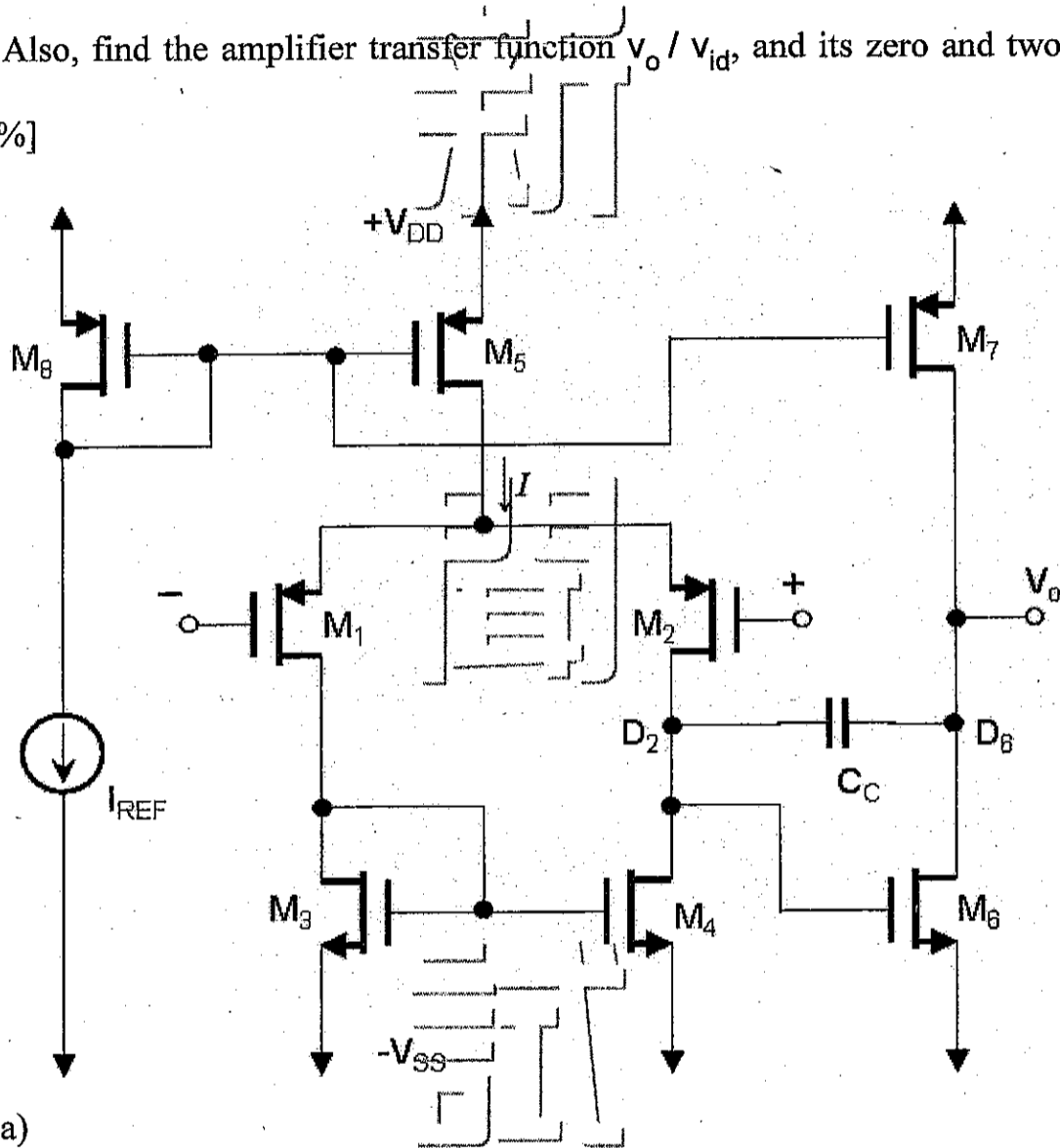


Fig. 5(a)

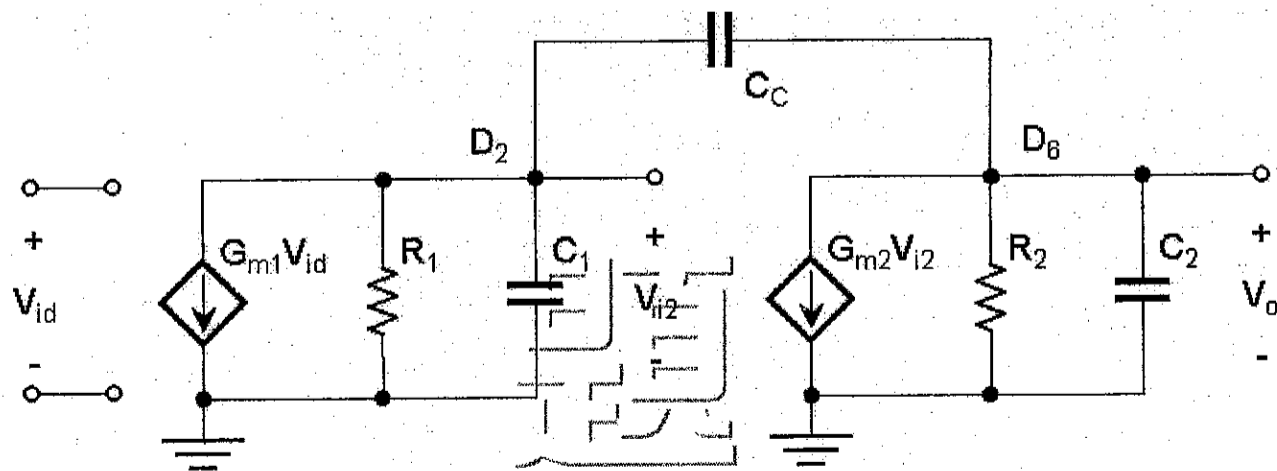


Fig. 5(b)