※ 考生請注意：本試題 ☑可 □不可 使用計算機

1. In Fig. 1, the diodes and the op-amp are ideal. (a) Plot the transfer characteristic. (6 分) (b) Plot the waveform of V_O when $V_I = 15\sin(4\pi t)$. (5 分)

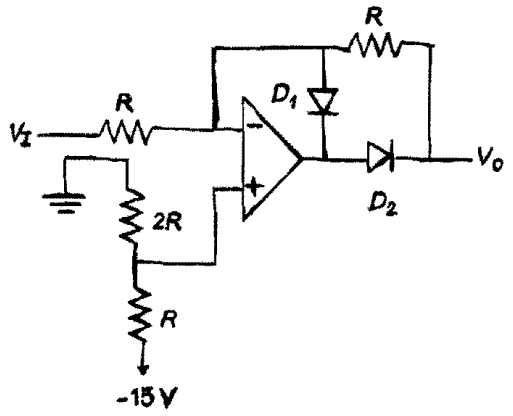

Fig. 1

2. Figure 2 shows a circuit suitable for op-amp application. For all transistors β=100, V_{BE}=0.7 V, $|V_T|$=25 mV, and $r_o = \infty$. (a) For inputs grounded and output held at 0 V, find the emitter currents of all transistors (you can ignore base currents for dc analysis). (4 分) (b) Calculate the gain of the amp with a load of 10 kΩ. (8 分) (c) With load as in (b), calculate the value of the capacitor C required for a 3-dB frequency of 1 kHz. (6 分)

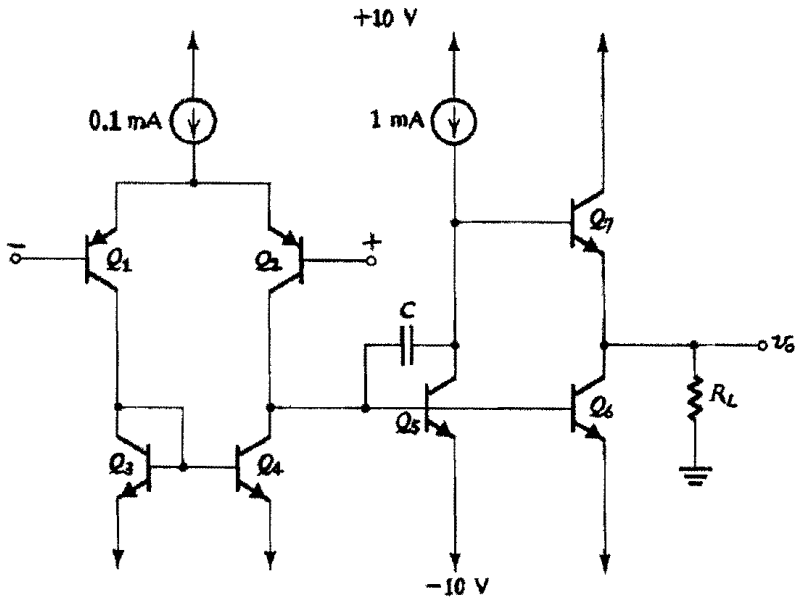

Fig. 2

(背面仍有題目,請繼續作答)

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3. Analyze the circuit in Fig. 3. The transistors are biased by a current source such that the transistors have $\beta = 100$, $r_\pi = 5\ \text{k}\Omega$, $g_m = 20\ \text{mA/V}$, $r_o = \infty$, $C_\mu = 2\ \text{pF}$, and $C_\pi = 6\ \text{pF}$ (a) Find the midband gain；(7 分) (b) Find f_H by using the open-circuit time constant。(8 分)

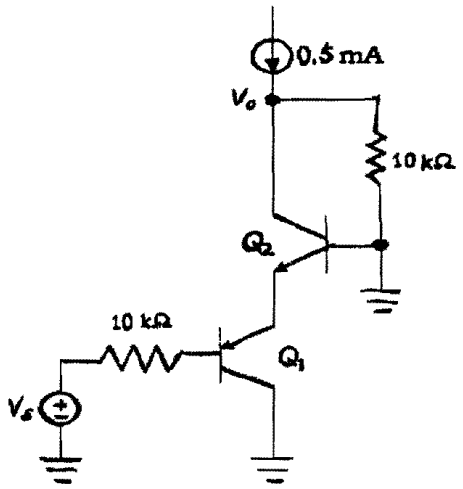

Fig. 3

4. For the diff. amp in Fig. 4, (a) Sketch the differential half-ckt and the common-mode half-ckt. (8 分) (b) Find the differential gain, the differential input resistance, the common-mode gain, and the common-mode input reistance. Assume that $\beta = 100$, V_T=25 mV, and $r_o = \infty$. (12 分)

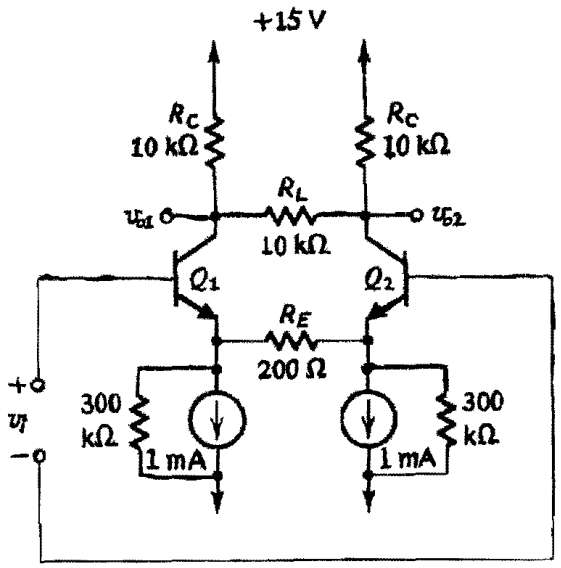

Fig. 4

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5. In Fig. 5, the transistors are assumed to have common-emitter current gain β, emitter resistance r_e, and early voltage $V_A=\infty$. Find expressions for $A_f \equiv v_o/v_s$, R_{in}, and R_{out}. (20 分)

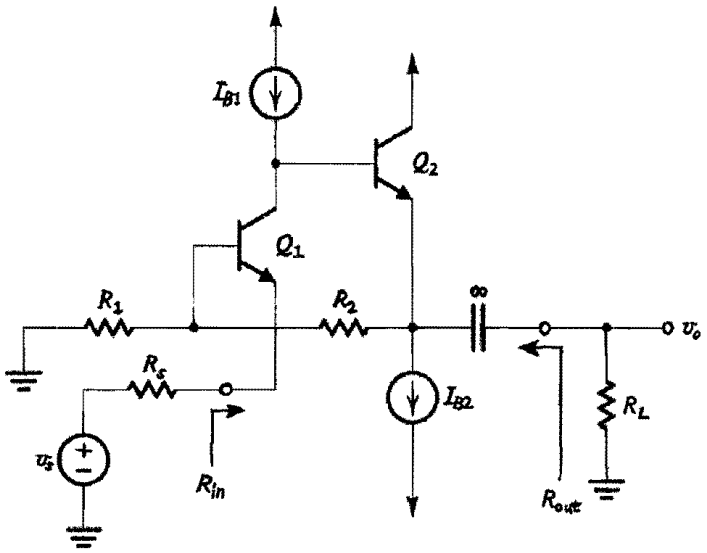

Fig. 5

6. In Fig. 6, an approach realizing the OR function of six input variables is shown. (a) Sketch the CMOS realization for the logic gates in the figure，(6 分) (b) Assuming that the transistors in the circuit are properly sized to provide each gate with a current-driving capability equal to that of the basic matched inverter, find the number of transistors and the total area. Assume that the basic inverter has the $(W/L)_n$ ratio of 1.2 μm / 0.8 μm and the $(W/L)_p$ ratio of 3.6 μm / 0.8 μm 。(10 分)

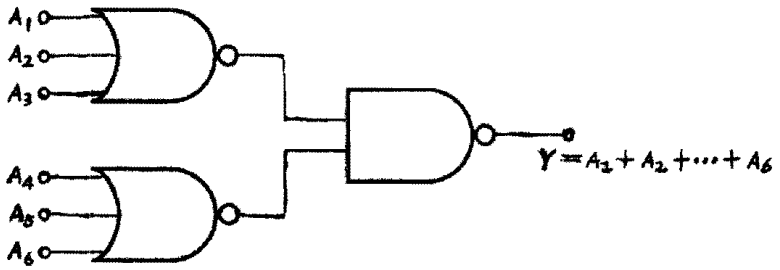

Fig. 6