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1. In the common-gate amplifier circuit, Q_2 and Q_3 are matched, $k_n'(W/L)_n = k_p'(W/L)_p = 4\ \text{mA/V}^2$, and all transistors have $|V_t| = 0.8\ \text{V}$ and $|V_A| = 20\ \text{V}$. Transistor Q_1 has $\chi = 0.2$. The signal v_{sig} is a small sinusoidal signal with no dc component. (a) Neglecting the effect of V_A, find the dc drain current of Q_1 and the required value of V_{BIAS}. (4 分) (b) Find the values of R_{in} and R_{out}. (6 分) (c) Find the voltage gain v_o/v_{sig}. (4 分) (d) How large can v_{sig} be (peak-to-peak) while maintaining saturation-mode operation for Q_1 and Q_2. (4 分)

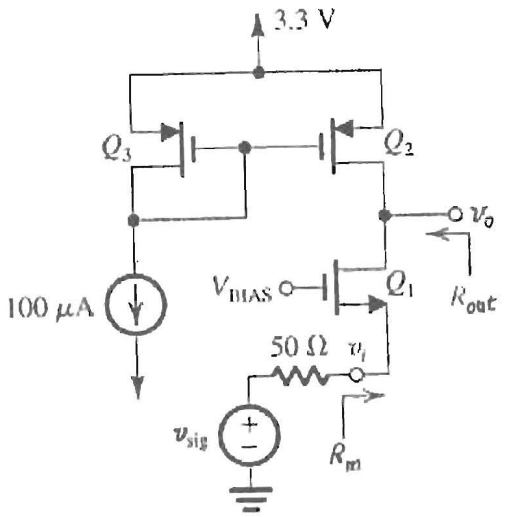

Fig. 1

2. Find the voltage gain and the input resistance of the amp shown below, assuming $\beta = 50$. (16 分)

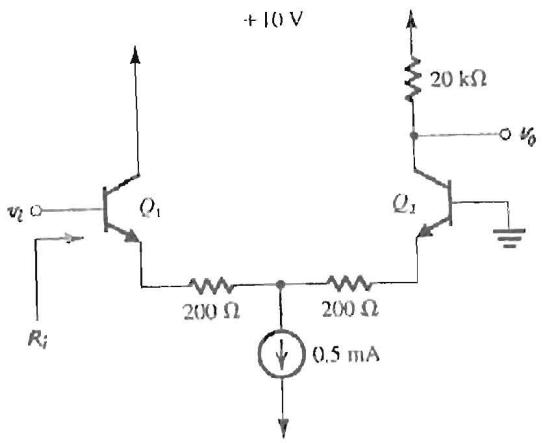

Fig. 2

(背面仍有題目,請繼續作答)

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3. Assuming that the small-signal parameters r_{π_1}, r_{π_2}, β_1, β_2, g_{m_1}, g_{m_2}, r_{o_1}, r_{o_2}, etc, are known, for the CC-CE transistor pair (r_o cannot be ignored),

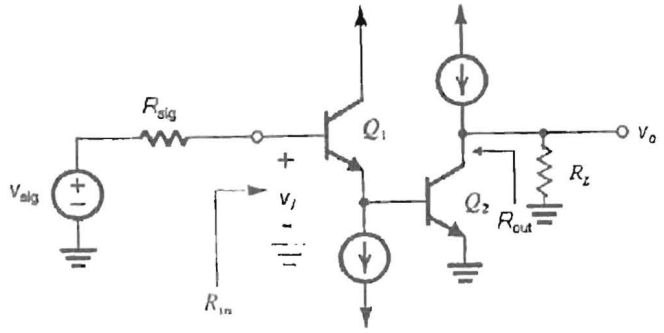

Fig. 3

(a) Determine R_{in}, R_{out}, and $A_{vo} \equiv \left.\frac{v_o}{v_i}\right|_{R_L=\infty}$ in terms of the small-signal parameters. (9 分) (b) Plot the equivalent circuit of the transistor pair using R_{in}, R_{out}, and A_{vo}. (3 分) (c) Assuming that the internal high-frequency capacitors C_{π_1}, C_{π_2}, C_{μ_1}, and C_{μ_2} are known, find f_H using the open-circuit time constant and Miller's theorem. (6 分)

4. The op amp in the following figure has an open-loop gain of 10^5 and a single-pole rolloff with ω_{3dB}=10 rad/s. (a) Sketch the Bode plot for the loop gain $A(s)\beta(s)$. (6 分) (b) Find the frequency at which $|A\beta|=1$, and find the corresponding phase margin. (6 分) (c) Find the closed-loop transfer function, and its zeros and poles. (8 分) (d) Is the circuit stable? Why? (4 分)

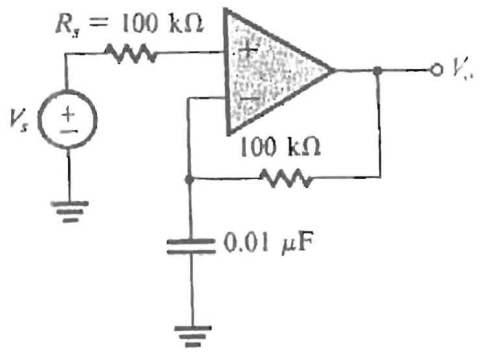

Fig. 4

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5. Consider a feedback amp for which the open gain $A(s)$ is given by

$$A(s)=\frac{1000}{\left(1+s/10^4\right)\left(1+s/10^5\right)^2}.$$

If the feedback factor β is independent of frequency, (a) find the frequency at which the phase shift is 180° (4 分), and (b) find the critical value of β at which oscillation will commence (6 分).

6. A dc amp having a single-pole response with pole frequency 10^4 Hz and unity-gain frequency of 10 MHz is operated in a loop whose frequency-independent feedback factor is 0.1. (a) Find the low-frequency gain, the 3-dB frequency, and the unity-gain frequency of the closed-loop amp (10 分). (b) By what factor does the pole shift? (4 分)