國立清華大學命題紙

九十一學年度 電子工程 系(所) ________ 組碩士班研究生招生考試

科目 電子學 科號 2503 2602 共 三 頁第 1 頁 *請在試卷【答案卷】內作答

1. A bipolar junction transistor is biased at $I_C = 2$ mA and T = 300°K. The transistor parameters are $\beta = 100$, $V_A = 100$ V.
   (a) Sketch its low frequency hybrid-π equivalent circuit and determine the transconductance, base input resistance and collector output resistance. (4%)
   (b) Based on your hybrid-π circuit, determine the h-parameters: h_{ie}, h_{re}, h_{fe} and h_{oe}. (4%)
   (c) Repeat (b) when a resistor $r_{cb} = 1$ MΩ is connected between base and collector. (8%)

2. A MOSFET with parameters $k_n = 0.5$ mA/V², $V_{TN} = 1$ V is used in the circuit of Fig. 1. The component values are $V^+ = -V^- = 10$ V, $I_Q = 2$ mA, $C_1 = C_2 = \infty$, $R_i = 500$ Ω, $R_D = 2.5$ kΩ.
   (a) Find the dc voltage of source V_s. (4%)
   (b) Sketch the small signal equivalent circuit. (4%)
   (c) Calculate the values R_{in} and V_o/V_i. (6%)

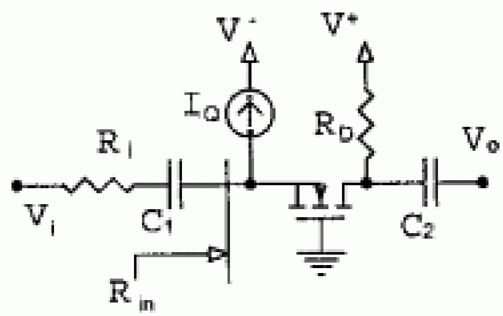

Fig. 1

3. A common source equivalent circuit is shown Fig. 2, the transistor transconductance is $g_m = 3$ mA/V. (a) Calculate the equivalent Miller capacitance. (b) Determine the upper 3dB frequency (in Hz) for the small signal voltage gain. (10%)

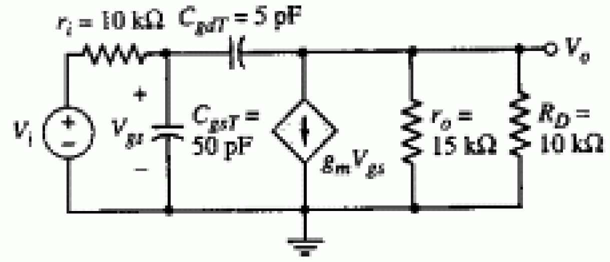

Fig. 2

4. Consider the current source shown in Fig. 3, with transistor parameters $\mu_n C_{ox} = 40\ \mu A/V^2$, $V_{TH} = 1$ V, and $\lambda = 0$. Let $V^+ = 5$ V, $V^- = 0$, $V_{GS2} = 1.85$ V. Design the circuit such that $I_{REF} = 0.25$ mA, and $I_O = 0.1$ mA. (10%)

5. The transistors in the circuit of Fig. 4 have $\beta = 100$, $V_{BE(on)} = 0.7$ V, and $V_A = 100$ V. Determine the differential- and common-mode input resistance, R_{id} and R_{icm}. Assume thermal voltage $V_T = 25$ mV. (15%)

6. Sketch and carefully label v_o for each of the circuits described in Fig. 5, given the power supplies are ±10 V, and $v_{in} = 1$ Sin wt volts.
   (a) The circuit has the form given in Fig. 1 with $R_f = 5$ kΩ and $R_2 = 1$ kΩ. In addition, an ideal diode is connected in series with R_2 (cathode on the left). (5%)
   (b) The circuit is the same as in part (a) except that the diode is connected in series with R_f. (5%)

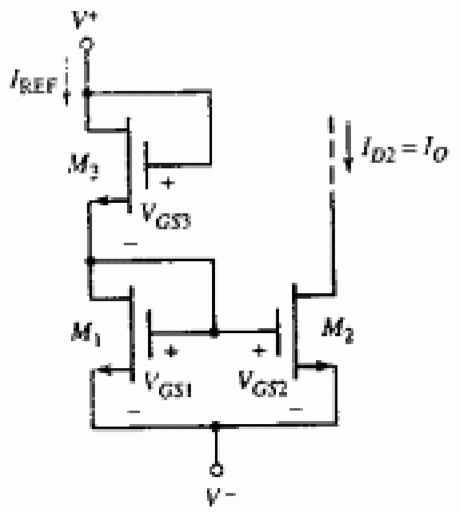

Fig. 3

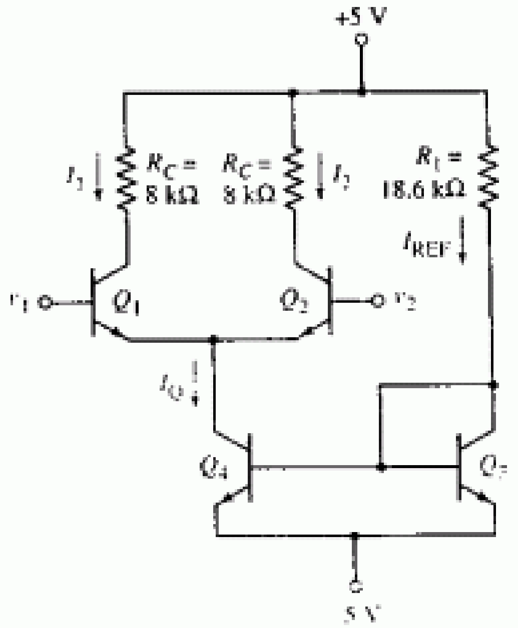

Fig. 4

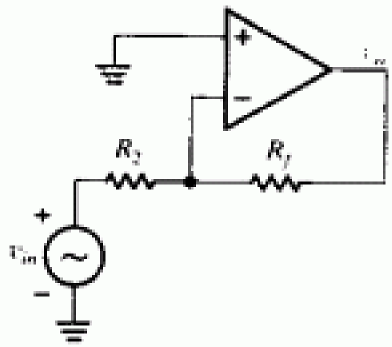

Fig. 5

7. An inverting-style op amp circuit is constructed with $R_2 = 10\ k\Omega$ and R_f replaced by an inductor L = 100 mH. Determine the stability of this circuit. Assuming that the op amp has the A_{OL} gain-phase characteristics as shown in Fig.6. (10%)

8. The circuit illustrated in Fig. 7 is known as a Wien bridge oscillator.
   (a) Determine the frequency of oscillation. (5%)
   (b) Find the op amp closed-loop gain needed to just make this circuit oscillate. (5%)
   (c) Plot the gain-phase characteristics of the feedback network. (5%)

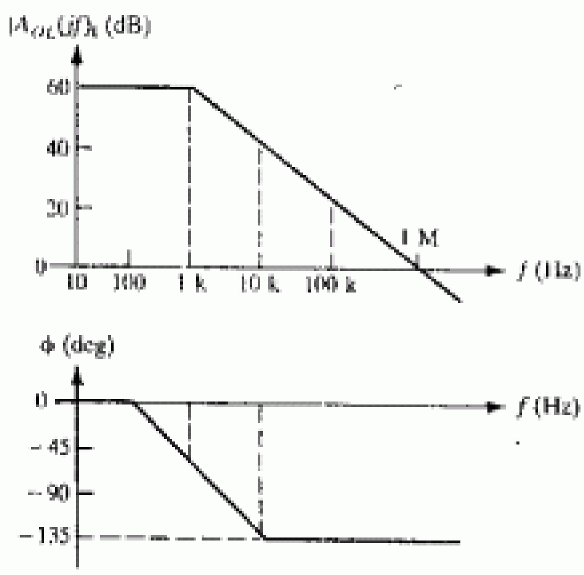

Fig. 6

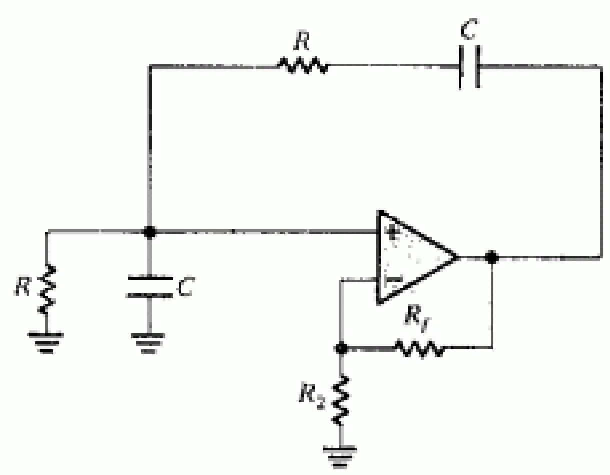

Fig. 7