國立臺灣師範大學103學年度碩士班招生考試試題

科目：**電子學**　　適用系所：**電機工程學系**

注意：1.本試題共3頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

1. (10 points) An op amp with a finite open-loop gain A is used in the circuit of Fig. 1, derive the expressions for the input resistance R_i and the transresistance $R_m = v_o/i_i$.

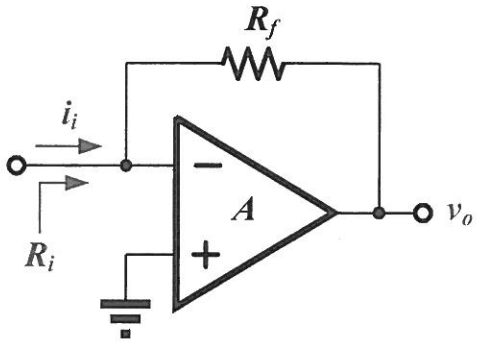

Fig. 1

2. (10 points) For all NMOS devices in the circuit of Fig. 2, $V_{tn} = 0.5$ V, $\lambda = \gamma = 0$, $L = 1$ μm, and $\mu_n C_{ox} = 50\ \mu$A/V^2. If Q_1 and Q_3 are made to have $W = 1$ μm, and Q_2 and Q_4 are made to have $W = 10$ μm, find V_2 and I_{D2}.

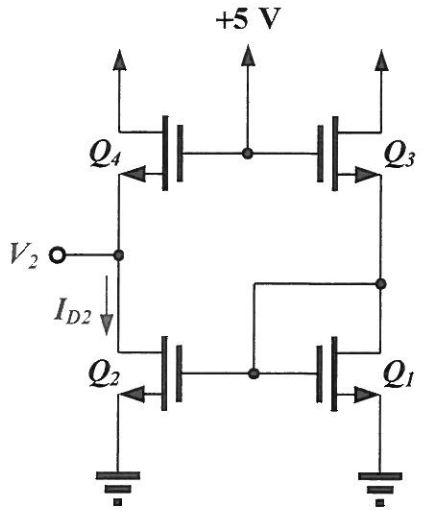

Fig. 2

3. (20 points) The Widlar current source, as shown in Fig. 3, is used to generate an output current $I_O = 10$ μA. Assume that V_{BE} is 0.7 V at a current of 1 mA, and $V_T =$ 25 mV. The transistors Q_1 and Q_2 are matched, and the effect of finite β is neglected.
   (a) If $I_{REF} = 1$ mA, determine the values of the resistors R_1 and R_2. Some values of *ln* function are given in following hint.
   (b) If $R_2 = 0$ Ω, find V_{BE1} and new value of the resistor R_1 for the same output current of 10 μA.
   [Hint: $ln(0.01) = -4.61$, $ln(0.1) = -2.3$, $ln(10) = 2.3$, $ln(100) = 4.61$, $ln(1000) = 6.91$]

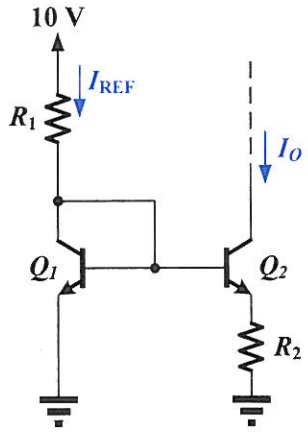

Fig. 3

4. (20 points) The MOSFETs in the circuit of Fig. 4 are matched, having $k_n'(W/L)_1 = k_p'(W/L)_2 = 1$ mA/V^2 and $V_{tn} = |V_{tp}| = 0.5$ V.
   (a) Find the drain currents I_{D1} and I_{D2}?
   (b) For $r_o = \infty$, what is the voltage gain of the amplifier from G to D?
   (c) For finite r_o ($|V_A| = 20$ V), what is the voltage gain from G to D? And, find the input resistance R_{in} at G.

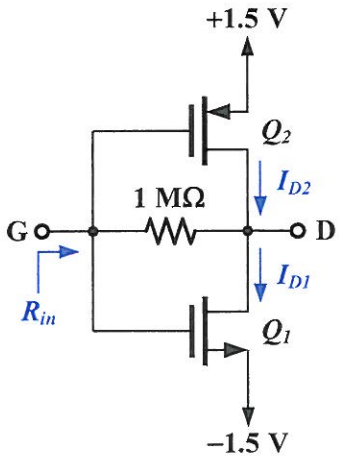

Fig. 4

5. (20 points) The transistor in the circuit of Fig. 5 has $\beta = 99$, $V_T = 25$ mV, and $V_{BE} = 0.7$ V.
   (a) Find the dc collector current I_C and the dc voltage V_C at the collector.
   (b) Draw the small-signal equivalent circuit of the amplifier, and analyze the resulting circuit to determine the voltage gain v_o/v_i.

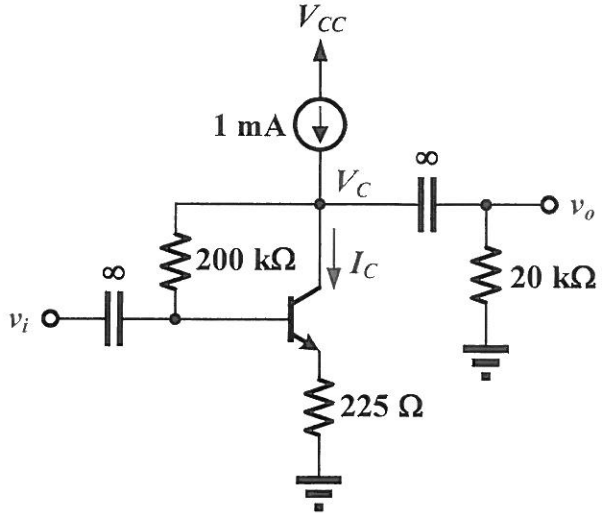

Fig. 5

6. (20 points) Consider the circuit of Fig. 6, $I = 200$ μA, $V_{OV} = 0.25$ V, and $C_{gs} = C_{gd} = 1$ pF.
   (a) Find the dc gain v_o/v_{sig}.
   (b) Calculate two high-frequency poles, f_{p1} and f_{p2}, and write an estimate equation of f_H in terms of f_{p1} and f_{p2}.

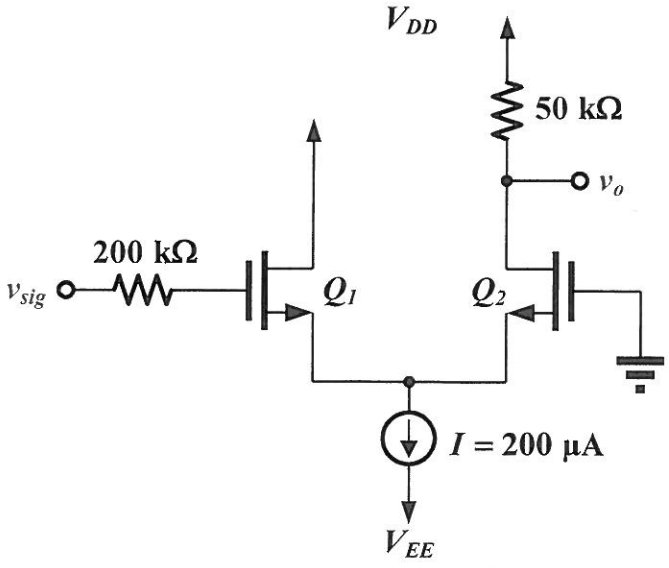

Fig. 6