國立臺灣師範大學 113 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，否則依規定扣分。

1. (10 points) Figure 1 shows an inverting amplifier with an ideal OPA and a current meter. Assume that $R_1 = 3\ \text{k}\Omega$, $R_f = 12\ \text{k}\Omega$, and $R_L = 2\ \text{k}\Omega$.

(a) Find i_m if $v_i = -0.6$ V.

(b) Find v_i if $i_m = 2$ mA.

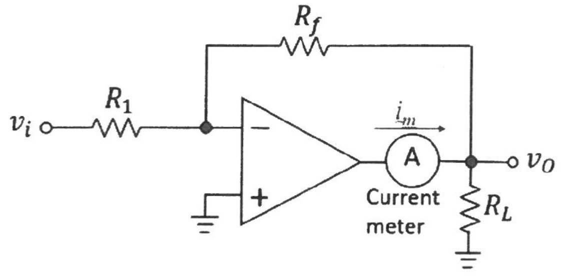

Figure 1

2. (20 points) Figure 2 shows a BJT amplifier. Assume that $V_{CC} = 10$ V, $R_{sig} = 20\ \text{k}\Omega$, $R_{B1} = R_{B2} = 100\ \text{k}\Omega$, $R_E = 1\ \text{k}\Omega$, and $R_L = 2\ \text{k}\Omega$. The transistor has $\beta = 100$, $V_{BE} = 0.7$ V, and the thermal voltage $V_T = 25$ mV. Neglect the effect of r_o. (Note: An infinite capacitance means that the capacitance is large enough to act as a short circuit at all signal frequencies of interest. However, the capacitor still blocks dc.)

(a) Find I_C.

(b) Find R_i, R_o, and v_o/v_{sig}.

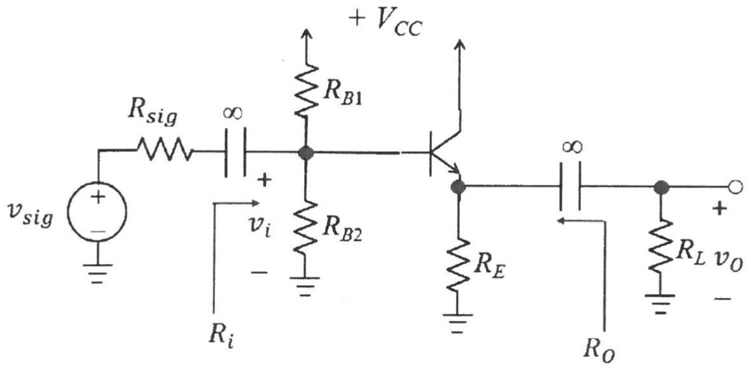

Figure 2

3. (20 points) Figure 3 shows an NMOS amplifier. Assume that $V_{DD} = V_{SS} = 4$ V, $R_D = 2$ kΩ, and $R_S = 5$ kΩ. The NMOS transistor has $V_t = 1$ V, $\mu_n C_{ox} = 400\ \mu A/V^2$, $L = 0.2\ \mu m$, and $W = 2\ \mu m$. Neglect the effect of r_o. (Note: An infinite capacitance means that the capacitance is large enough to act as a short circuit at all signal frequencies of interest. However, the capacitor still blocks dc.)

(a) Find I_D and g_m.

(b) Find R_i, and v_o/v_i.

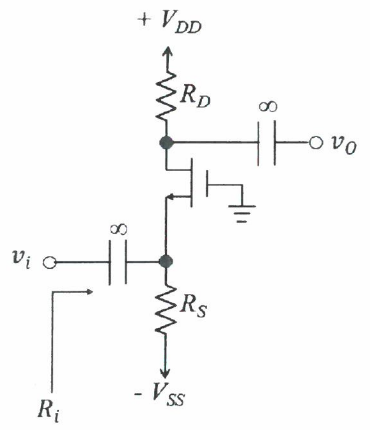

Figure 3

4. (20 points) Figure 4 shows a MOS differential pair. Let $V_{DD} = V_{SS} = 3$ V, $\mu_n C_{ox} = 400\ \mu A/V^2$, $L = 0.2\ \mu m$, $W = 2\ \mu m$, $V_t = 1$ V, $I = 1$ mA, $R_D = 4$ kΩ, and neglect the effect of r_o. Assume that the current source I requires a minimum voltage of 1 V to operate properly.

(a) For $V_{G1} = V_{G2} = -0.2$ V, find V_S.

(b) Let $V_{G1} = V_{G2} = V_{CM}$. What is the highest permitted value of V_{CM}?

(c) Let $V_{G1} = V_{G2} = V_{CM}$. What is the lowest value allowed for V_{CM}?

(d) Let $v_{id} = V_{G1} - V_{G2}$. Find v_o/v_{id}.

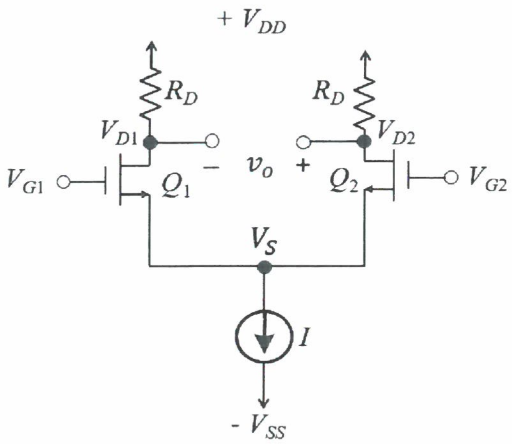

Figure 4

5. (15 points) Figure 5 shows the equivalent circuit of a voltage amplifier. Assume that $R_{sig} = 30\ \text{k}\Omega$, $R_i = 60\ \text{k}\Omega$, $R_o = 10\ \text{k}\Omega$, $R_L = 90\ \text{k}\Omega$, $A_{vo} = 100\ \text{V/V}$, and $C_i = 0.05\ nF$.

(a) Find the amplifier voltage gain V_o/V_{sig} at midband. (i.e. the midband gain A_M)

(b) Find the upper 3-dB frequency f_H.

(c) Find $v_o(t)$ for $v_{sig}(t) = 0.1 sin 10^6 t$.

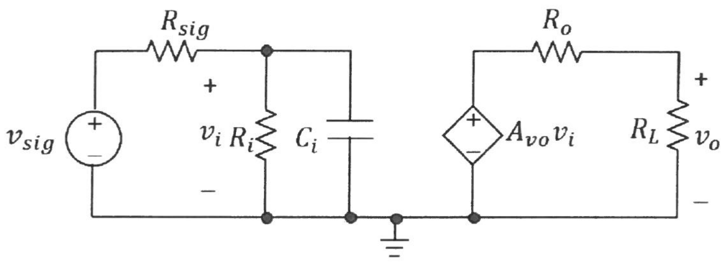

Figure 5

6. (15 points) Figure 6 shows a feedback amplifier. Let $R_{D1} = 5\ \text{k}\Omega$, $R_{D2} = 10\ \text{k}\Omega$, $R_1 = 2\ \text{k}\Omega$, $R_2 = 18\ \text{k}\Omega$, $g_{m1} = g_{m2} = 10\ mA/V^2$. For simplicity, neglect r_o of each of Q_1 and Q_2.

(a) Determine the feedback topology of this amplifier.

(b) Find the loop gain $A\beta$.

(c) Find the closed-loop gain v_o/v_{sig}.

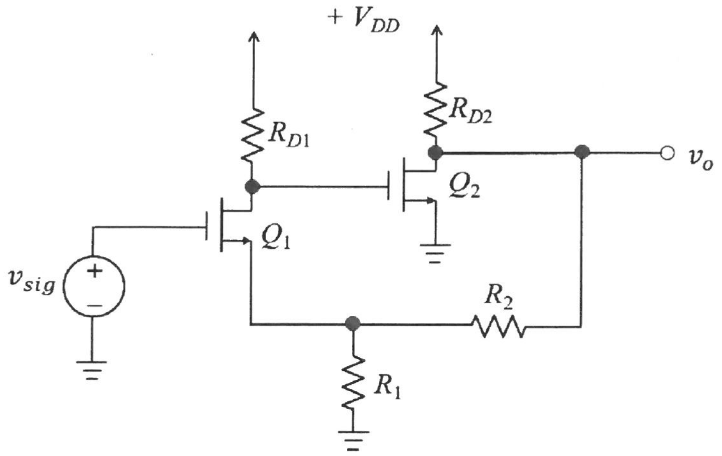

Figure 6