國立臺灣師範大學 112 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 4 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. (20 points) Figure 1(a) shows an amplifier composed of a cascade of three stages. Each stage is a voltage amplifier, which is modeled as shown in Figure 1(b).

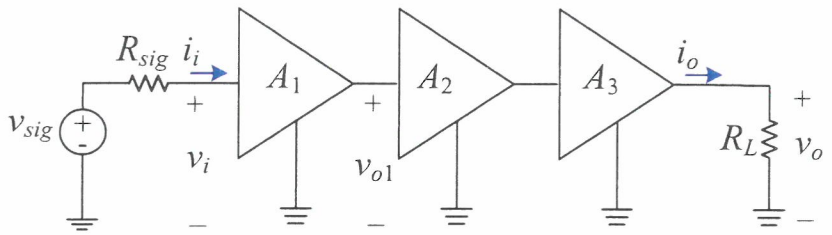

Figure 1(a)

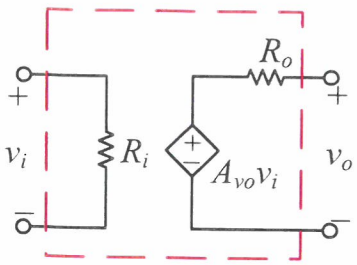

Figure 1(b)

Assume that $R_{sig} = 20\ \text{k}\Omega$, $R_L = 1\ \text{k}\Omega$, and the parameters of each amplifier are listed as follows.

Stage	R_i	R_o	A_{vo}
A_1	50 kΩ	5 kΩ	10 V/V
A_2	20 kΩ	10 kΩ	20 V/V
A_3	90 kΩ	1 kΩ	1 V/V

Find v_{o1}/v_{sig}, v_o/v_i, i_o/i_i, and the power gain P_o/P_i.

2. (20 points) Figure 2 shows an amplifier composed by an ideal op Amp.

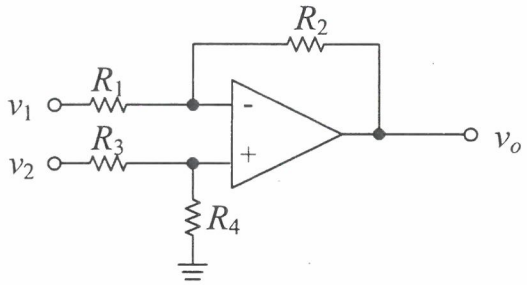

Figure 2

(1) Assume that $v_1 = 0\ \text{V}$, $v_2 = 2\ \text{V}$, $R_1 = R_3 = 1\ \text{k}\Omega$, and $R_2 = R_4 = 2\ \text{k}\Omega$. Find v_o.

(2) Assume that $v_1 = 2\sin(10t) - 0.01\sin(10^4 t)$, V, $v_2 = 2\sin(10t) + 0.01\sin(10^4 t)$, V. Find v_o for each case.

(a) $R_1 = R_2 = R_3 = R_4 = 2\ \text{k}\Omega$.

(b) $R_1 = 1\ \text{k}\Omega$, $R_2 = 2\ \text{k}\Omega$, $R_3 = 4\ \text{k}\Omega$, and $R_4 = 8\ \text{k}\Omega$.

(c) $R_1 = 1\ \text{k}\Omega$, $R_2 = 2\ \text{k}\Omega$, $R_3 = 3\ \text{k}\Omega$, and $R_4 = 3\ \text{k}\Omega$.

3. (20 points) Figure 3 shows an amplifier composed by an *npn* bipolar junction transistor.

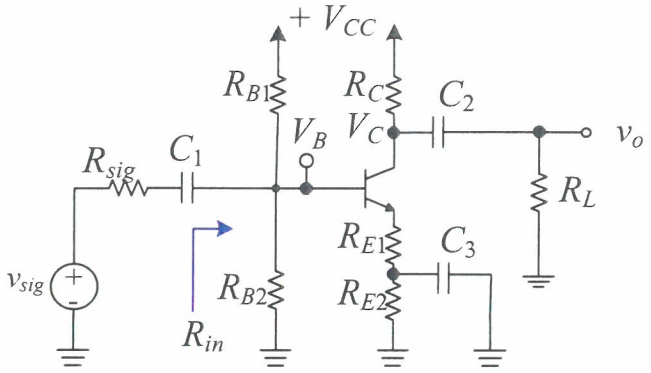

Figure 3

Assume that $V_{CC} = 10$ V, $R_{B1} = 60$ kΩ, $R_{B2} = 40$ kΩ, $R_C = 1$ kΩ, $R_{E1} = 200$ Ω, $R_{E2} = 800$ Ω, $R_{sig} = 10$ kΩ, $R_L = 10$ kΩ, $V_{BE} = 0.7$ V, β = 100, the thermal voltage $V_T = 25$ mV, and $r_o = \infty$.

(1) Find the dc voltages: V_B and V_C.

(2) Assume that the capacitors C_1, C_2, and C_3 act as a perfect short circuit as far as the signal is concerned. Find the input resistance R_{in} and the overall voltage gain v_o/v_{sig}.

4. Fig. 4 shows a common-source amplifier biased by an ideal current source I. Let $R_{sig} = R_D = R_L = 50$ kΩ, $R_G = 1$ MΩ, $C_{C1} = C_{C2} = 0.1$ μF, and $C_S = 5$ μF. The NMOS transistor is specified to have $g_m = 4$ mA/V, $C_{gs} = 20$ fF, and $C_{gd} = 5$ fF. Ignore the channel-length modulation, i.e., $\lambda = 0$.

   (a) (10 points) Find the lower 3-dB frequency f_L using the method of short-circuit time constants.

   (b) (10 points) Find the upper 3-dB frequency f_H using the method of open-circuit time constants.

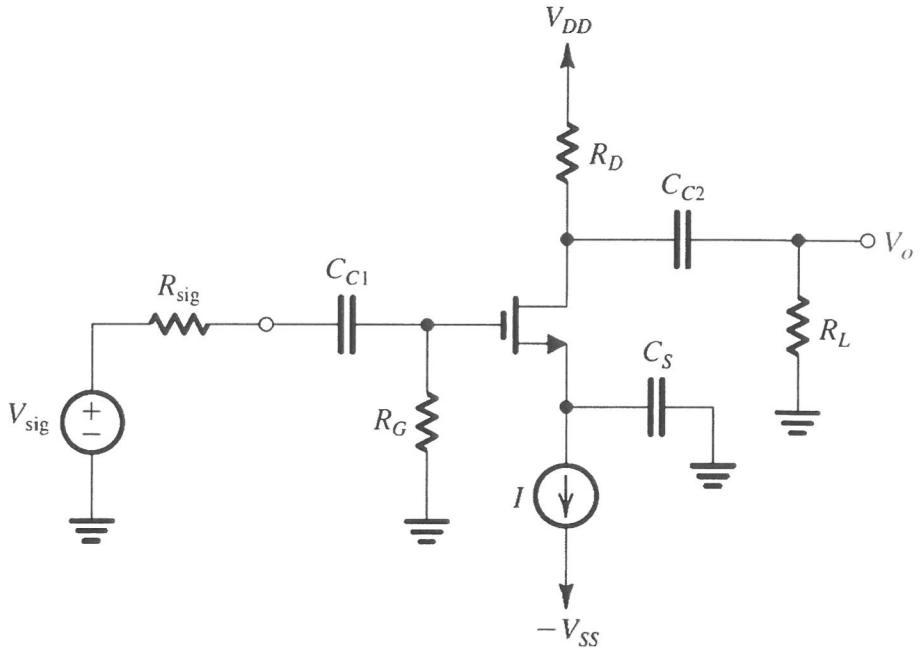

Fig. 4

5. (20 points) The feedback amplifier of Fig. 5 consists of a common-gate amplifier formed by Q_1 and R_D, and a feedback circuit formed by the capacitive divider (C_1, C_2) and the common-source transistor Q_f. Note that the bias circuit for Q_f is not shown. Assume that C_1 and C_2 are sufficiently small that their loading effect on the common-gate amplifier can be neglected. Also neglect r_o and body effect. Find the values of $A_f \equiv V_o/I_s$, R_{in}, and R_{out} for the case in which $g_{m1} = 5$ mA/V, $g_{mf} = 2$ mA/V, $R_D = 10$ kΩ, $C_1 = 0.9$ pF, $C_2 = 0.1$ pF.

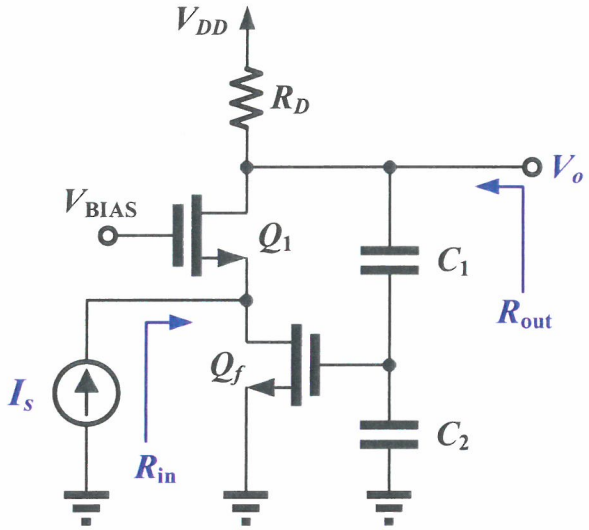

Fig. 5