國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：電子學【電機系碩士班甲組、乙組、戊組、電波領域聯合】　　題號：431006

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

1. (15%) Figure 1 shows the inverting configuration voltage amplifier with R = 1 kΩ. (a) Please find the close loop gain of V_O/V_I if the operational amplifier (op amp) is ideal. (b) Please find the close loop gain of V_O/V_I if the open loop gain of op amp is 10 V/V. (c) If the op amp is a low-pass STC with $A(f)=\frac{10}{1+\frac{j2\pi f}{1000}}$, please find the high frequency close loop gain of V_O/V_I at f = 1 GHz. (5%, 5%, 5%)

2. (25%) Consider the voltage amplifier of Figure 2 with a BJT device having β =100 when it is biased in the active region, the AC signal voltage V_{sig}, signal resistance R_{sig} = 10kΩ and coupling capacitors C_{C1} and C_{C2} which can block DC component and pass AC component. The voltage supplies V_{CC} = 10V and the thermal voltage V_T = 25mV. The constant voltage drop 0.7V approximation can be used for the turn-on of a p-n junction, and the constant voltage drop V_{CE} ~ 0.2V approximation can be used when the BJT is biased in the saturation region. In addition, other resistances are also included, such like R_1 = 2MΩ, R_2 = 2MΩ, R_E = 5kΩ, R_C = 5kΩ, R_L = 5kΩ. Please come out following parameters: (a) transconductance g_m, (b) input resistance R_{in}, (c) overall AC voltage gain V_o/V_{sig}. (d) Please describe the advantages of the existing of emitter resistance R_E compared with no R_E. (5%, 5%, 5%, 10%)

3. (30%) Figure 3 is the two-stage CMOS op amp configuration. All NMOSFETs have the same W/L = 10μm/0.5μm, V_{tn} = 0.5V, $\mu_n C_{ox}$ = 200 μA/V^2. All PMOSFETs have the same W/L = 40μm/0.5μm, V_{tp} = -0.5V, $\mu_p C_{ox}$ = 50 μA/V^2. $|V_A|$ (for all devices) = 10V, V_{DD} = V_{SS} = 3V, I_{REF} = 100μA. Neglect the effect of V_A on bias current. Please find (a) the transconductance g_m and r_o of Q_2, (b) the voltage gain of the first stage A_1 and the second stage A_2, (c) the input common-mode range, and (d) the output voltage range. (10%, 10%, 5%, 5%)

4. (30%) Figure 4 shows a CC-CE amplifier with R_{sig} = R_L = 5 kΩ, I_1 = I_2 = 1mA, and identical transistors with β = 100, f_T = 500 MHz, C_μ = 5pF, and C_C = 2μF. The thermal voltage V_T = 25mV. For simplicity, neglect r_o and r_x effect. Please find (a) the input resistance R_{in}, (b) the midband gain A_M, (c) the C_π of the BJTs, and (d) 3-dB frequency of the upper end of the midband, f_H (using open-circuit time-constants method). (5%, 5%, 5%, 15%)

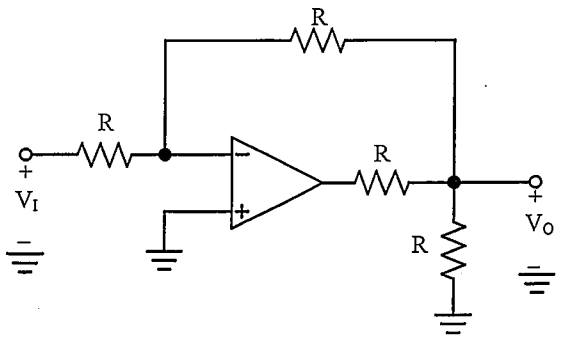

Figure 1.

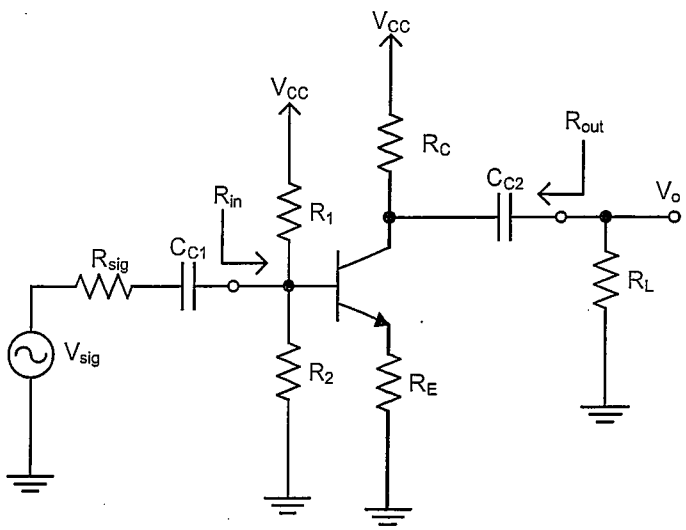

Figure 2.

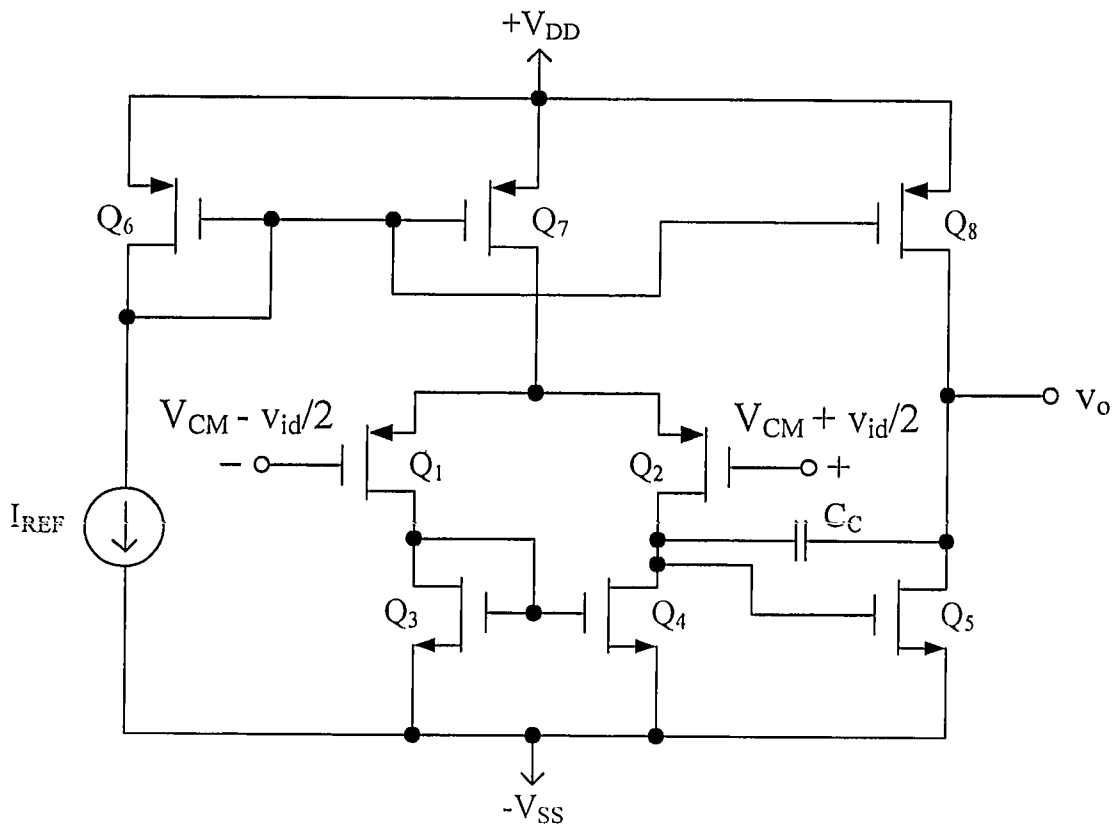

Figure 3.

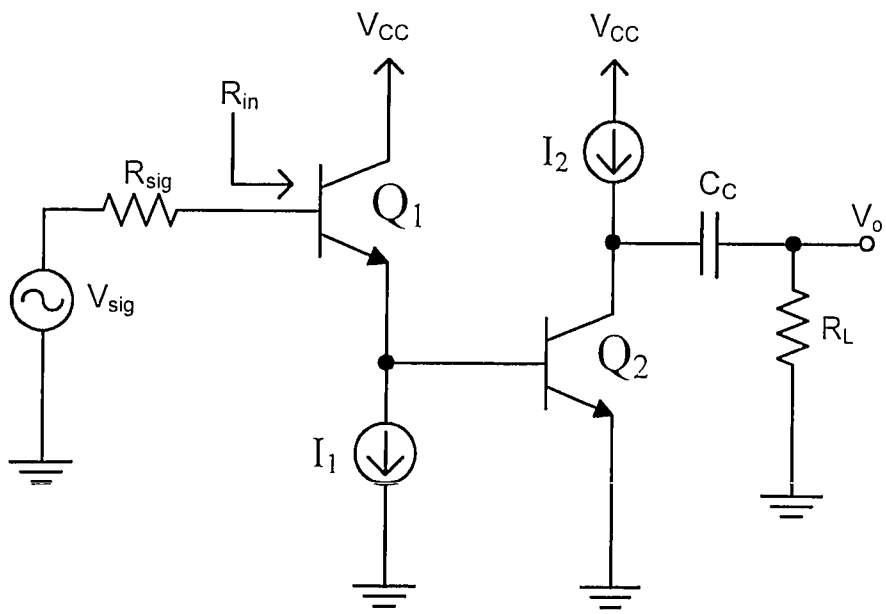

Figure 4.