國立中央大學 110 學年度碩士班考試入學試題

所別： 電機工程學系 碩士班 固態組(一般生)　　
電機工程學系 碩士班 系統與生醫組(一般生)
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科目： 電子學

本科考試禁用計算器　　＊請在答案卷(卡)內作答

1. 計算題(10 分)
Figure P1 shows the BJT amplifier with a current gain β of BJT is 100, thermal voltage V_T = 25 mV and collector current $I_C = I_S \exp(V_{EB} / V_T)$. Assume that when V_{EB} is 0.7 V, I_C is 1 mA. When V_C is –5 V, design R_E and R_C to make I_C equal to 4 mA. Note the answer must be rounded to two decimal places. (R_E 與 R_C 各 5 分。)

2. 計算題(10 分)
Figure P2 shows a BJT amplifier with infinite current gain β. Assume the threshold voltage V_D of ideal diode is 0.7 V and ignore the base current of BJT. Find out the operation region of transistor Q_1 and Q_2 (active or saturation region). (全對 10 分，部分對 3 分，全錯 0 分。)

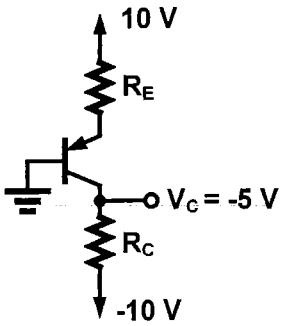

Fig. P1

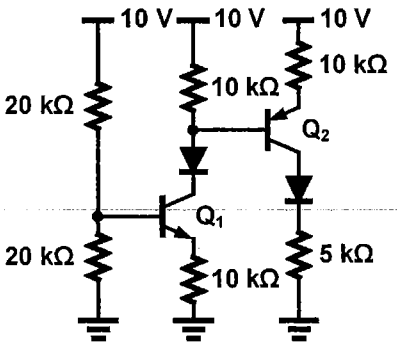

Fig. P2

3. 計算題(10 分)
Figure P3 shows a common-source amplifier which is biased at saturation region with threshold voltage V_{th} = 1 V and channel-length modulation parameter $\lambda = 0.01\ V^{-1}$. Find the small signal voltage gain $-g_m r_o$.

4. 計算題(10 分)
The ideal OP amplifier circuit is shown in Fig. P4.
4-1 (5 分) If differential gain $A_d = \infty$, find out V_o.
4-2 (5 分) If differential gain A_d = 50 V/V, find out V_o.

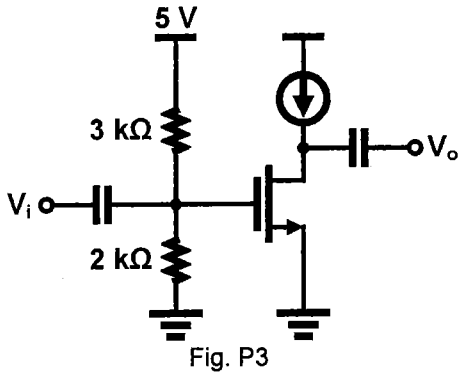

Fig. P3

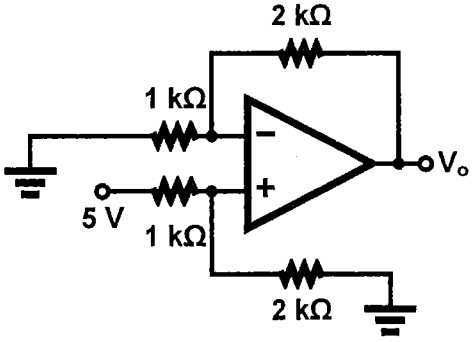

Fig. P4

注意:背面有試題

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5. 計算題(10 分)
Figure P5 shows a possible realization of the folded cascode amplifier. All the MOSFETs have $|V_A| = 5$ V. Let $I = 100$ μA, and assume that the MOSFETs are operating at $V_{OV} = 0.2$ V. Assume the current sources are ideal. Please determine
5-1 (5 分) the output resistance R_{out}.
5-2 (5 分) the voltage gain A_V.

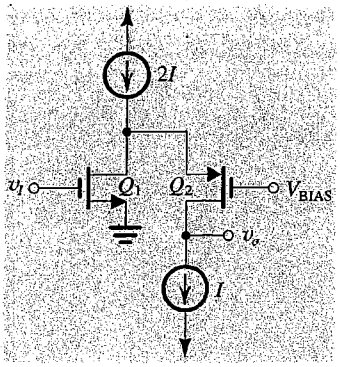

Fig. P5

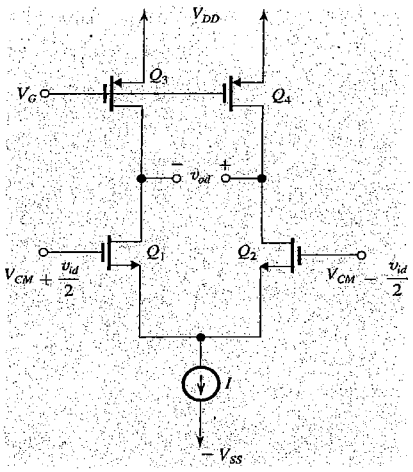

Fig. P6

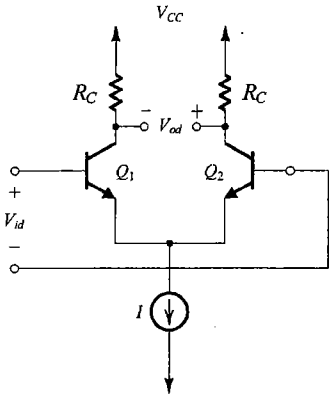

Fig. P7

6. 計算題(10 分)
The differential amplifier of figure P6 is fabricated in a 0.18-μm CMOS technology for which $\mu_n C_{ox} = 4\mu_p C_{ox} = 400$ μA/V^2, and $|V_A'| = 10$ V/μm. If the bias current $I = 200$ μA and all transistors have a channel length twice the minimum and are operating at $|V_{OV}| = 0.2$ V. Please find
6-1 (5 分) W/L of Q_1 and Q_2.
6-2 (5 分) the differential voltage gain A_d.

7. 計算題(10 分)
Figure P7 shows that a bipolar differential amplifier with a bias current $I = 0.5$ mA utilizes transistors for which $V_A = 50$ V and $\beta = 100$. The collector resistances $R_C = 5$ kΩ and the mismatch $\triangle R_C$ between the collector resistances is within 10%.
7-1 (5 分) Find differential voltage gain A_d.
7-2 (5 分) Find the common-mode rejection ratio (CMRR).

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8. 計算題(15 分)

Figure P8 shows a generalized high-frequency equivalent circuit for the common-source amplifier. For the case of g_m = 2 mA/V, C_{gs} = 20 fF, C_{gd} = 5 fF, C_L = 30 fF, R'_{sig} = 10 kΩ, and R'_L = 20 kΩ.

8-1 (5 分) Use the Miller approach to estimate the 3-dB frequency f_H.

8-2 (5 分) Use the method of open-circuit time constants to estimate the 3-dB frequency f_H.

8-3 (5 分) Also, find the frequency of the transmission zero f_Z.

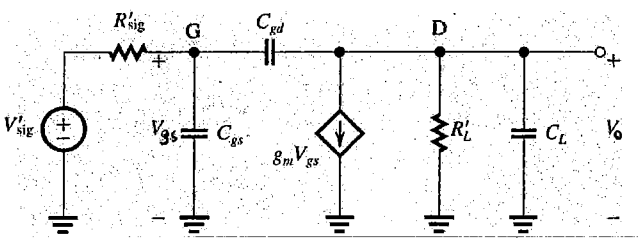

Fig. P8

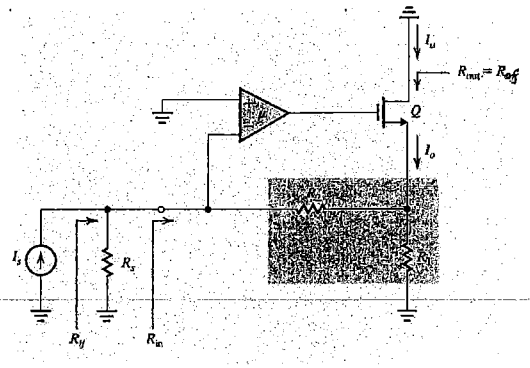

Fig. P9

9. 計算題(15 分)

Figure P9 shows a feedback current amplifier formed by cascading an inverting voltage amplifier μ with a MOSFET Q. For the case of μ = 100 V/V, $R_s = R_{id} = \infty$, R_1 = 10 kΩ, and R_2 = 90 kΩ; For Q: g_m = 5 mA/V and r_O = 20 kΩ.

9-1 (5 分) Find the value of close-loop gain $A_f = I_O/I_S$.

9-2 (5 分) Find the value of input resistance R_{in}.

9-3 (5 分) Find the value of output resistance R_{out}.