

國立中央大學 108 學年度碩士班考試入學試題

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科目： 電子學

本科考試禁用計算器

*計算題需計算過程，無計算過程者不予計分

1. 計算題(10 分)

For the circuit given in Figure P1, an operational amplifier with limited differential gain $A_d = 100$ is used. If $R_1 = 1 \text{ k}\Omega$, $R_2 = 4 \text{ k}\Omega$, $R_3 = 1 \text{ k}\Omega$, $R_4 = 4 \text{ k}\Omega$, $V_1 = 1 \text{ V}$ and $V_2 = 4 \text{ V}$, find the output voltage V_o .

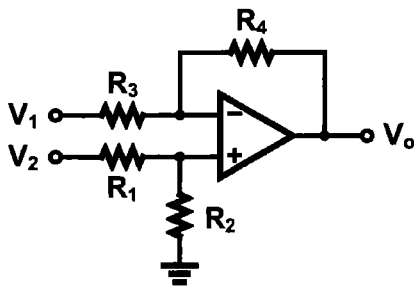


Fig. P1

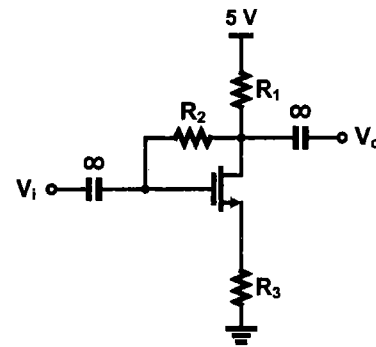


Fig. P2

2. 計算題(15 分)

For the circuit given in Figure P2, the device parameters of the NMOSFET are $V_t = 1 \text{ V}$, $\lambda = 0 \text{ V}^{-1}$, $\gamma = 0 \text{ V}^{-1}$, $\mu_n C_{ox} = 200 \mu\text{A/V}^2$, $W/L = 10 \mu\text{m} / 1 \mu\text{m}$ and drain current $I_D = 1 \text{ mA}$. If $R_1 = 2 \text{ k}\Omega$, $R_2 = 4 \text{ k}\Omega$, $R_3 = 1 \text{ k}\Omega$, Find the following,

2-1 (5 分) the value of the output resistance R_o .

2-2 (10 分) the voltage gain v_o/v_i .

3. 計算題(10 分)

For the circuit shown in Figure P3, the current equation of the diodes are $I_D = I_S \times \exp(V_D/2V_T)$ and $V_T = 0.025 \text{ V}$. Using the diode small-signal model to find the voltage gain V_o/V_i .

[Hint: Find the location of the nodes V_o and V_i]

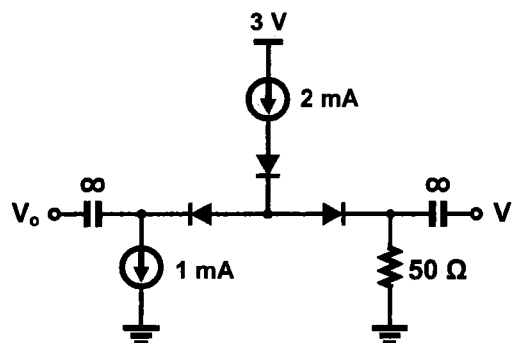


Fig. P3

參考用

注意:背面有試題

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4. 計算題(15 分)

Figure P4 shows a npn BJT amplifier. The transconductance of the npn transistor $g_m = 20\text{m A/V}$, $\beta = 100$ and $v_{BE} = 0.7\text{ V}$. If $R_1 = 10\text{ k}\Omega$, $R_2 = 10\text{ k}\Omega$, $R_3 = 3\text{ k}\Omega$, $R_4 = 4\text{ k}\Omega$, Neglect the Early effect, please find the following:

- 4-1 (5分) Calculate the value of the amplifier input resistance R_{in} .
- 4-2 (5分) Find the voltage gain V_{o1}/V_i .
- 4-3 (5分) Find the voltage gain V_{o2}/V_i .

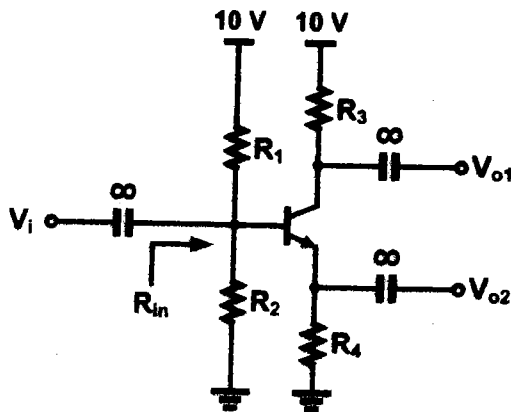


Fig. P4

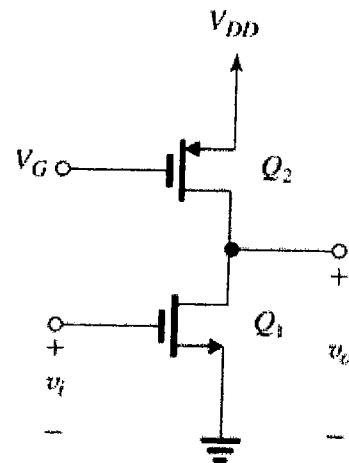


Fig. P5

參考用

5. 計算題(14 分)

Figure P5 shows a common source amplifier with a current-source load implemented with a p-channel MOSFET Q_2 . Both Q_1 and Q_2 operate in saturation. The amplifier is fabricated in a process for which $\mu_n C_{ox} = 2\mu_p C_{ox} = 0.2\text{ mA/V}^2$, $V_{An} = |V_{Ap}| = 20\text{ V}/\mu\text{m}$, $V_{tn} = -V_{tp} = 0.5\text{ V}$, and $V_{DD} = 2.5\text{ V}$. The two transistors have $L = 0.5\text{ }\mu\text{m}$ and are to be operated at a current I_D of 0.1 mA with two transistors operating at overdrive voltage $|V_{OV}| = 0.2\text{ V}$. Please find the required values of the following.

- 5-1 (4 分) V_G .
- 5-2 (4 分) $(W/L)_1$, and $(W/L)_2$. (每子題 2 分)
- 5-3 (6 分) Voltage gain A_v .

注意:背面有試題

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6. 計算題(16 分)

Figure P6 shows a PMOS differential amplifier and both Q_1 and Q_2 operate in saturation. Let $V_{tp} = -0.8$ V, and $k'_p(W/L) = 12.5$ mA/V². Neglect channel-length modulation.

6-1 (4 分) For $v_{G1} = v_{G2} = 0$ V, find V_{SG} for each of Q_1 and Q_2 .

6-2 (4 分) If the current source requires a minimum voltage of 0.4 V, find the input common mode range, $V_{CM\ max}$ and $V_{CM\ min}$. (每子題 2 分)

6-3 (4 分) The current source has an output resistance $R_{SS} = 40$ k Ω . If the output is taken single-endedly, find $|A_d|$ and $|A_{cm}|$. (每子題 2 分)

6-4 (4 分) Following 6-3, if the output is taken differentially and there is a 1% mismatch between the drain resistances, find $|A_d|$ and $|A_{cm}|$. (每子題 2 分)

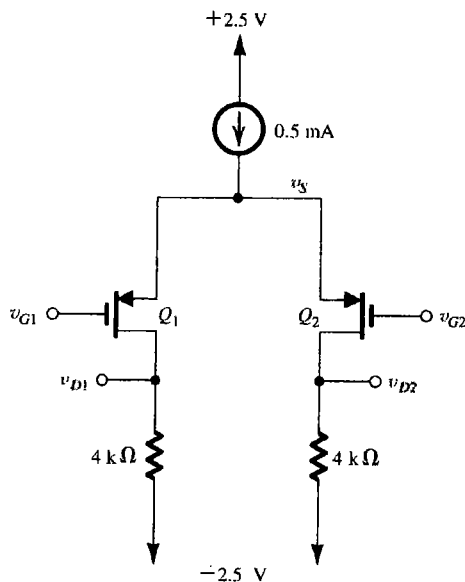


Fig. P6

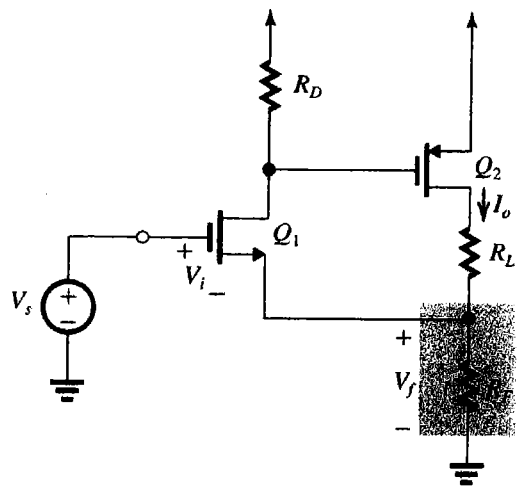


Fig. P7

7. 計算題(20 分)

Figure P7 shows a feedback transconductance amplifier. For the case of $g_{m1} = g_{m2} = 5$ mA/V, $R_D = 1$ k Ω , $r_{o2} = 20$ k Ω , $R_F = 100$ Ω , and $R_L = 1$ k Ω . For simplicity, neglect r_{o1} and take r_{o2} into account only when calculating output resistance.

7-1 (10 分) Find the value of close-loop gain $A_f = I_o/V_s$.

7-2 (10 分) Find the value of output resistance R_{of} .

參考用