

九十四學年度台灣大學電機系電子學(一)期末考

- For the transistor shown in Fig. 1, assume $\beta = \infty$ and $v_{BE} = 0.5V$ at the edge of conduction. For what range of V_B does the transistor stay in active region? (13%)

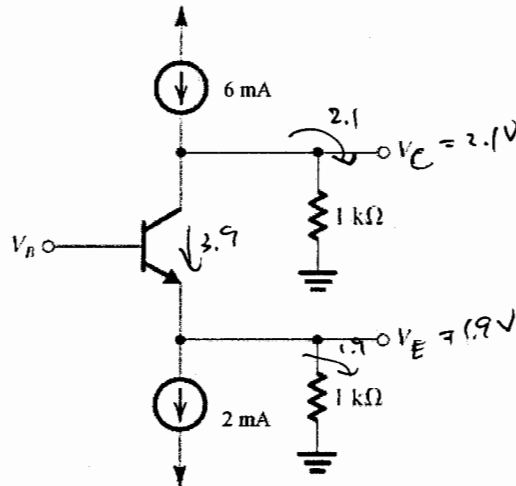


Fig. 1

- For the circuit shown in Fig. 2, $R_1 = 9.3 \text{ k}\Omega$, $R_2 = 6.7 \text{ k}\Omega$, $R_3 = 3 \text{ k}\Omega$, $R_4 = 3.7 \text{ k}\Omega$, $R_5 = 1 \text{ k}\Omega$, $R_6 = 2 \text{ k}\Omega$. Assume all transistors $\beta = \infty$. Find the collectors current of Q_1 , Q_2 and Q_3 . (12%)

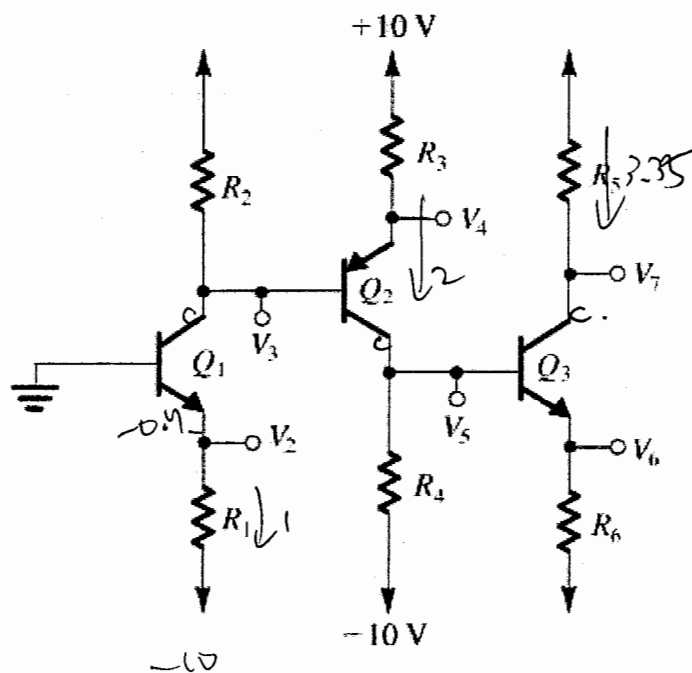


Fig. 2

Ans: 3

3. The NMOS transistor in the common-gate amplifier of Fig. 3, has $V_t = 2V$, $k_n' W/L = 1 \text{ mA/V}^2$, and $\lambda = 0$.

(a) Find I_D , V_D , and g_m . (12%)

(b) Find input resistance R_{in} , small signal voltage gain (v_o/v_{i2}), and output resistance R_o . (13%)

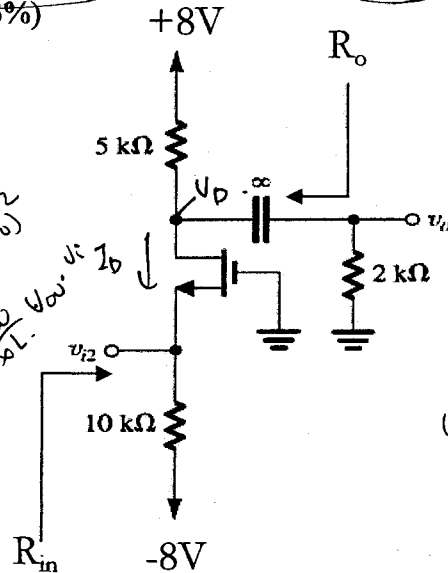


Fig. 3

4. Consider the circuit in Fig. 4. Given that $\mu_n C_{ox} = 50 \mu\text{A/V}^2$, $V_t = 1V$, $R_1 = 2 \text{ k}\Omega$, $R_2 = 4 \text{ k}\Omega$, $R_3 = 2 \text{ k}\Omega$, $(W/L)_1 = 5/1$, $(W/L)_2 = 20/1$, $(W/L)_3 = 2.5/1$, $(W/L)_4 = 10/1$.

(a) Find I_{D2} . (5%)

(b) Find V_A and V_B . (10%)

(c) If R_3 is changed to $8 \text{ k}\Omega$, find V_A and V_B . (10%)

Hint: neglect the body effect and channel length modulation.

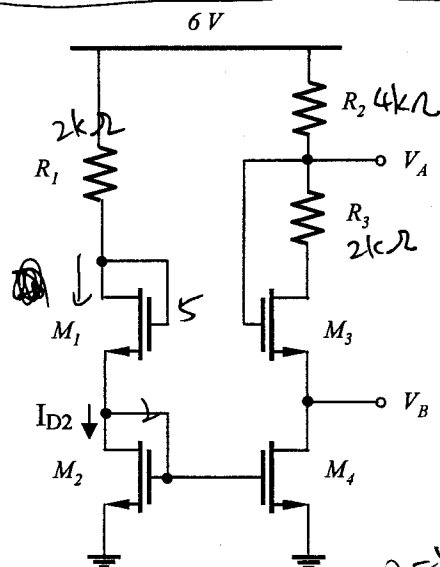


Fig. 4

$$0 = V_{D2}^2 + V_{D2} - 6 = (V_{D2} - 2)(V_{D2} + 3)$$

$$\Rightarrow V_{D2} = 2$$

$$\eta - 3V_{D2} = 0.25(2V_{D2} - 2)^2$$

$$= (V_{D2} - 1)^2$$

$$= V_{D2}^2 - 2V_{D2} + 1$$

5. For the circuit shown in Fig. 5, $R_{B1} = 50 \text{ k}\Omega$, $R_{B2} = 100 \text{ k}\Omega$, $\beta_F = 100$, and $|V_{BE(ON)}| = 0.7 \text{ V}$.

(a) Find the values for R_{C1} , R_{C2} , R_{E1} , and R_{E2} , such that $I_{C1} = I_{C2} = 0.8 \text{ mA}$, $V_{EC1} = 3.5 \text{ V}$, and $V_{CE2} = 4.0 \text{ V}$. (15%)

(b) With the R_{C1} , R_{C2} , R_{E1} , and R_{E2} determined in (a), and if $R_{B1} = 100 \text{ k}\Omega$, $R_{B2} = 50 \text{ k}\Omega$, what are the operation regions for transistors Q_1 and Q_2 (you need to derive your answer with calculations)? Assuming in the saturation region, the transistor $|V_{CE(saturation)}| = 0.2 \text{ V}$. (10%)

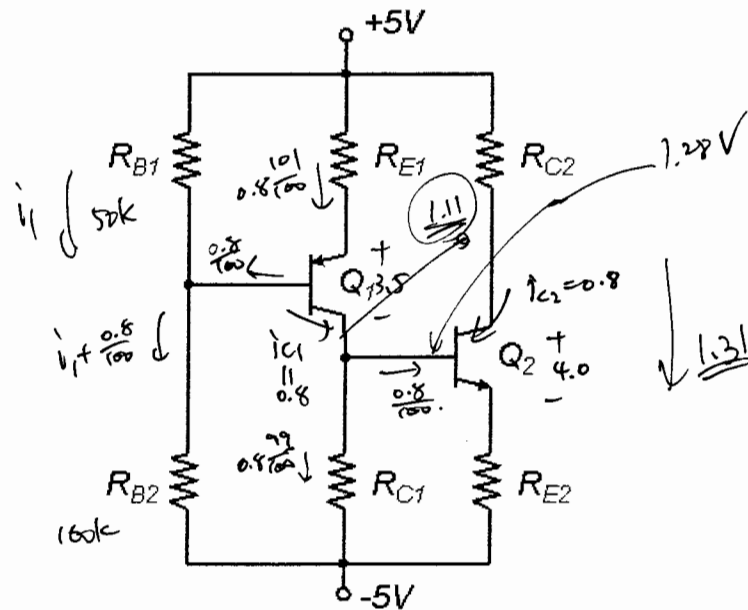
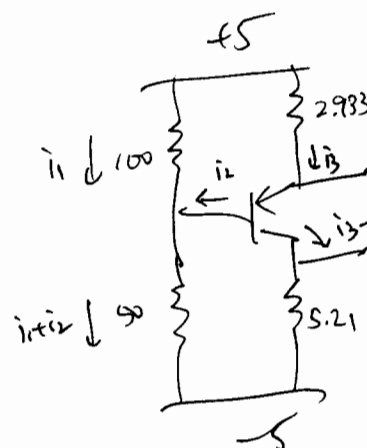


Fig. 5



$$2 = (3 - 1.7639)(5 - 1.7639 - 1) - \frac{1}{2}(3 - 1.7639)^2$$

$$\begin{cases} 100 i_1 + 50(i_1 + i_2) = 10 \\ 100 i_1 = i_3 \cdot 2.933 + 0.9 \\ 2.933 \times i_3 + 0.2 + (i_3 - i_2) \cdot 5.21 = 10 \\ i_3 \cdot 4.39 + 1.05 + 50 i_2 = 10 \\ i_3 \cdot 9.143 + 0.2 - 5.21 i_2 = 10 \end{cases}$$

$$\begin{cases} i_1 = 0.0436 \\ i_3 = 1.2499 \\ i_2 = 0.0694 \end{cases}$$

$$\begin{cases} i_3 - 4.39 + i_2 \cdot 50 = 8.95 \\ i_3 \cdot 9.143 + 0.2 - 5.21 i_2 = 9.8 \end{cases}$$

$$\begin{cases} \Delta_3 = 540 \\ \Delta_2 = 29.55 \end{cases}$$