1. Please sketch the circuit of operational amplifier-based unity-gain buffer (voltage follower) and briefly describe the function of this circuit. (10 分)

2. The following circuit is the so-called difference amplifier, assume the operational amplifier used in the circuit is ideal and let \( R_3 = R_1 \) and \( R_4 = R_2 \), please
(a) Calculate its differential gain \( A_d \equiv \frac{V_o}{(V_{12}-V_{11})} \). (5 分)
(b) Calculate the input resistance of this difference amplifier. (5分)

3. The weighted summer is one of the most important applications of operational amplifier. Please use two operational amplifiers to design a weighted summer that provides \( V_o = 6 \, V_1 + 4 \, V_2 - 9 \, V_3 \). (10 分)
4. Please sketch the basic building block of DC power supply structure and briefly describe the function and waveform of this structure. (10 分)

5. In the following figure, the transistor has $V_t = 1.5V$, $K_n'(W/L) = 0.25 \text{ mA/V}^2$ and $\lambda = 0$. Determine
   (a) The small-signal voltage gain ($v_o/v_i$). (5分)
   (b) The input resistance ($R_{in}$). (5分)

![Circuit Diagram](image)

6. Please sketch the cross-section of a CMOS integrated circuit with p-substrate. (10分)

7. In the following figure, the length of NMOS and PMOS is the same, and $\mu_N = 3 \mu_P$. If we want to have the same rise time and fall time for the inverter, how to design the width of NMOS and PMOS? (10分)

![Inverter Diagram](image)

8. Explain why the two back-to-back diodes can not be used as a bipolar transistor. (10分)
9. If $\beta = 100$, determine
(a) The current of $I_C$. (5分)
(b) The voltage of $V_{CE}$. (5分)

\[ V^+ = +10 \, V \]
\[ R_e = 2 \, k\Omega \]
\[ R_c = 1 \, k\Omega \]
\[ V^- = -10 \, V \]

10. Compare the features of three various MOS amplifiers including common-source(CS), common-gate(CG) and common-drain(CD). (10 分)