

1. (10 分) 寫出並且推導 The Einstein Relation. (在什麼條件下此關係式成立並推導之)

2. (20 分) Schottky contact (1) p-type and (2) n-type energy band diagram.
 - (a) 畫出 (1)(2) Energy band diagram of a metal and semiconductor before contact. (5 分)
 - (b) 畫出 (1)(2) ideal energy band diagram after contact. (10 分)
 - (c) 畫出 (1)(2) ideal energy band diagram under reversed bias. (5 分)

3. (20 分) MOS Capacitor operation
畫出 MOS capacitor 的結構及
 - (1) energy band diagram in the **p-type** semiconductor and
 - (2) charge distribution on the metal and in the semiconductor for
 - (a) accumulation condition (5 分), (b) depletion condition (5 分), (c) threshold condition (5 分),
 - (d) inversion condition (5 分).

4. (35 分) An ideal n-channel MOSFET has the following parameters:
 $\mu_n=500 \text{ cm}^2/\text{V}\cdot\text{s}$, $W=40 \text{ }\mu\text{m}$, $L=2 \text{ }\mu\text{m}$, $t_{\text{oxide}}=400 \text{ \AA}$, $V_T=0.8 \text{ V}$, $C_{\text{oxide}}=6.9 \times 10^{-8} \text{ F/cm}^2$
 - (1) Plot I_D v.s. V_{DS} for $0 \leq V_{DS} \leq 5 \text{ V}$ and for $V_{GS}=0, 1, 2, 3, \text{ and } 5 \text{ V}$. Indicate the $V_{DS}(\text{sat})$ point and the value of $V_{DS}(\text{sat})$ on each curve. (15 分)
 - (2) Plot I_D v.s. V_{GS} for $V_{DS}=0.1 \text{ V}$ and for $0 \leq V_{GS} \leq 5 \text{ V}$. (10 分)
 - (3) Plot $[I_D(\text{sat})]^{1/2}$ v.s. V_{GS} for $0 \leq V_{GS} \leq 5 \text{ V}$. (5 分)
 - (4) If $V_G=3 \text{ V}$ and $V_{DS}=3 \text{ V}$. What is I_D ? (5 分)

5. (15 分) Si atoms (the concentration of 10^{15} cm^{-3}) are added to GaAs. If Si atoms are fully ionized atoms, and 10% Si can replace Ga atoms and 90% Si can replace As atoms at $T=300\text{K}$,
 - (1) Calculate the donor and acceptor concentrations. (5 分)
 - (2) Calculate the electron and hole concentrations. (5 分)
 - (3) Determine and plot the position of the Fermi level. (5 分)