

國立中正大學

112 學年度碩士班招生考試

試題

[第 3 節]

科目名稱	半導體元件物理
系所組別	機械工程學系光機電整合工程

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

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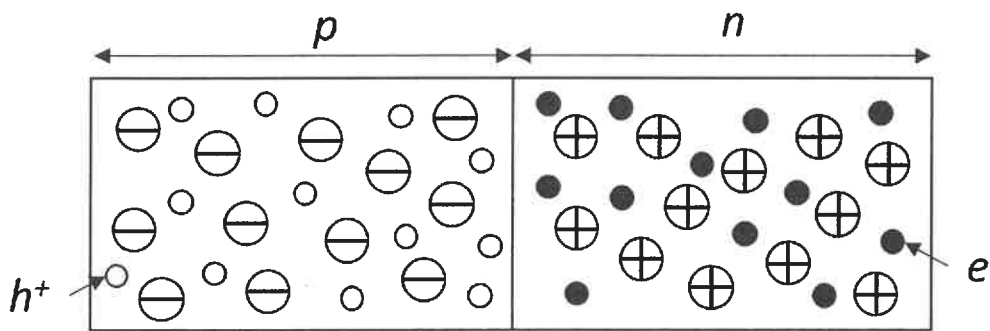
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系所組別：機械工程學系光機電整合工程

1. (20%) Please calculate the barrier height ΔE_n for $n = 1$ and 2. The effective mass in the well is $0.087 m_e$, and the width of quantum well is 15 nm.

$h = 6.624 \times 10^{-34}$ J s, $m_e = 9.1 \times 10^{-31}$ kg and $e = 1.6 \times 10^{-19}$ J/eV.

2. (30%) Please describe what happens of the (a) carrier concentrations (8%), (b) net space charge density (8%), (c) electric field (7%), and (d) electric field across the pn junction in equilibrium and in open circuit (7%).



3. (30%) Si atoms (the concentration of 10^{20} 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 $T=300\text{K}$,

- Calculate the donor and acceptor concentrations. (10%)
- Calculate the electron and hole concentrations. (10%)
- Determine and plot the position of the Fermi level. (10%)

4. (20%) For a semiconductor, $E_g = 2 \text{ eV}$, $m_p^* = 5 m_n^*$, $T = 300 \text{ K}$, and $n_i = 10^8 \text{ cm}^{-3}$ (E_g : energy gap, m_p^* : the density of states effective mass of the hole, m_n^* : the density of states effective mass of the electron, and n_i : the electron concentration in the intrinsic semiconductor).

- Determine the position of the intrinsic Fermi energy level with respect to the center of the bandgap. (10%)
- Impurity atoms are added so that the Fermi energy level is 0.5 eV below the center of the bandgap. What is the concentration of impurity atoms added? (10%)