國立中正大學
111 學年度碩士班招生考試
試 題
[第2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。

國立中正大學111學年度碩士班招生考試試題

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

1. **(20%)** What are direct-bandgap and indirect-gap materials? Explain their inter-band optical emission and absorption processes.

2. **(30%)** A new semiconductor has a bandgap of 0.5 eV and an intrinsic carrier density of N_i = 10^{14} cm^{-3} at T=300K. The electron and hole mobilities are 8000 cm^2/V-s and 4500 cm^2/V-s, respectively.
   (a) What are the electron and hole diffusion coefficients? **(10%)**
   (b) A bar made of this new material has a cross-sectional area of 100 μm^2 and a length of 10 μm. Find the current when a bias of 10 V is applied across the bar. **(10%)**
   (c) Schematically draw the absorption coefficient spectrum of this material. If a 100 mW CO_2 laser with wavelength of λ=10 μm is incident on this material, determine the number of electrons and holes generated per second. **(10%)**

3. **(10%)** Consider a Ge pn junction at T = 300 K with an acceptor concentration of N_a = 10^{15} cm^{-3} and a donor concentration of N_d = 10^{12} cm^{-3}, respectively. The intrinsic carrier density is N_i = 10^{10} cm^{-3}. Calculate the built-in potential barrier in this Ge pn junction.

4. **(40%)**

(a) Please sketch the ideal energy-band diagrams (before and after **"ohmic"** contact; before and after **"Schottky"** contact) for an ideal metal-to-*n*-type semiconductor junction. **(20%)**

(b) Please sketch the ideal energy-band diagrams for an ideal metal-to-*n*-type semiconductor **Schottky** junction under reverse bias. **(10%)**

(c) Please sketch the ideal energy-band diagrams for an ideal metal-to-*n*-type semiconductor **Schottky** junction under forward bias. **(10%)**

(please label the following terms in the depletion region: W (the width of depletion region), ϕ_m (work function of metal), ϕ_s (work function of semiconductor), ϕ_{Bn} (barrier height), χ (electron affinity of semiconductor), V_{bi} (built-in potential barrier), V_R (reverse-biased voltage) and V_a (forward-bias voltage).)