

國立臺灣科技大學

八十九學年度博士班招生考試試題

系所組別：電子工程系丙組

科目：半導體物理及元件

1.
 - (a) Explain the drift and diffusion current equations. 3%
 - (b) Describe the effect of temperature and doping concentration on the electron mobility. 4%
 - (c) Explain the Fermi level variation versus temperature for an n-type semiconductor doped with impurity $N_A = 1.0 \times 10^{17} \text{cm}^{-3}$. 5%
 - (d) Explain Schottky effect. 3%
 - (e) Explain the Shockley-Read-Hall recombination process 3%

2. In a forward-biased diode,
 - (a) Why most of the applied voltage is dropped across the pn junction space-charge region? 5%
 - (b) Explain the difference between the ideal and real diode current-voltage characteristics. 4%
 - (c) If we keep the doping N_A fixed at a value while we increase the doping N_D of a diode, what does the diode I-V change? explain why. 10%
 - (d) Explain the junction breakdown effect on the diode I-V characteristics *a function of temperature. 3%*

3. In a silicon p-n-p bipolar junction transistor,
 - (a) draw the energy band diagram of the p-n-p BJT operated in the saturation mode and forward-active mode you must draw quasi Fermi-levels. 10%
 - (b) Draw qualitatively the distribution of minority carriers in forward active mode for two p-n-p transistors with different base widths. 10%
 - (c) What is the base width effect on the current gain of the p-n-p BJT. 4%
 - (d) Draw the current-voltage characteristics of a p-n-p BJT in common-emitter configuration. 4%
 - (e) Explain the high-injection effect. 4%

4. In an enhancement-mode p-channel MOSFET,
 - (a) draw qualitatively the $I_{DS} - V_{DS}$ and $I_{DS} - V_{GS}$ characteristics at channel length $L = 5 \mu\text{m}$ and $L = 0.5 \mu\text{m}$. 10%
 - (b) Draw the energy band diagrams along the surface channel and in the direction perpendicular to the Si/SiO_2 interface for a pMOSFET operated in the saturation region. 9%
 - (c) Explain the punchthrough effect in a pMOSFET. 4%
 - (d) What is the effect of body bias on the output characteristics of a pMOSFET. 5%

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