

※ 考生請注意：本試題可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (15%) Explain in detail how energy bandgap is formed.
2. (15%) What is Fermi energy? (5%) Explain why the intrinsic Fermi level is not located in the center of the midgap level some times? (10%)
3. (20%) (a) Write down the ambipolar transport equation for an extrinsic n-type semiconductor under low injection (10%), (b) Consider an infinitely large, homogeneous n-type semiconductor with zero applied electric field. Assume that at time $t = 0$, uniform concentration of excess carriers exists in the crystal, but no additional excess carriers are generated for $t > 0$. Calculate the excess carriers' concentration as a function of time for $t \geq 0$. (10%)
4. (15%) A silicon one-sided abrupt p-n junction is doped with $N_A = 10^{18} \text{ cm}^{-3}$ and $N_D = 10^{16} \text{ cm}^{-3}$. At $T = 300\text{K}$, find the maximum electric field inside the p-n junction when a reversed bias of 10 V is applied.
5. (10%) An ohmic contact is doped with $N_D = 10^{20} \text{ cm}^{-3}$ and has an area of $0.1 \mu\text{m}^2$. Find the voltage drop across the ohmic contact if the conducting current is 1 mA and the specific contact resistance is $2 \times 10^{-8} \Omega\text{-cm}^2$.
6. (15%) An ideal metal-SiO₂-Si diode is doped with $N_A = 10^{18} \text{ cm}^{-3}$ in Si layer and has 3 nm of thickness in SiO₂ layer. At $T = 300 \text{ K}$, find the minimum capacitance on the C-V curve if the area of the diode is $10^3 \mu\text{m}^2$.
7. (10%) The threshold voltage and subthreshold swing of a n-channel MOSFET are 0.5 V and 75 mV/dec, respectively. If the drain current of the device is 1 nA when the gate voltage is 0.3 V, find the drain current when the gate voltage is 0 V.