國立雲林科技大學 112 學年度 碩士班招生考試試題

系所：電子系

科目：半導體元件

$h = 6.63 \times 10^{-34}$ J-s, $k = 8.62 \times 10^{-5}$ eV/K, $q = 1.6 \times 10^{-19}$ C, $\varepsilon_{Si} = 12 \times 8.85 \times 10^{-14}$ F/cm, $n_i = 10^{10}$ cm^{-3}, $\ln 10 \approx 2.3$

1. *Explain the following terms: (a) Impurity (b) Line dislocation* **(10%)**

2. *Explain the following terms: (a) Ternary compound semiconductor (b) Quaternary compound semiconductor* **(10%)**

3. *GaAs is more suited than Si for use in high-speed electronic devices. Please explain why.* **(10%)**

4. *Consider the Fermi-Dirac probability function $f_F(E)$, and E_F is the Fermi energy. Assume there are two temperatures $T_1 = 0$ K and $T_2 > 0$ K.*
   (a) *At T_1, will there be any electron having energy larger than E_F? Why?* **(5%)**
   (b) *At T_2, will there be any electron having energy larger than E_F? Why?* **(5%)**

5. *Consider a silicon semiconductor at room temperature in which the concentration of donor atoms is $N_d = 5 \times 10^{15}$ cm^{-3}. Calculate the thermal-equilibrium electron concentration and hole concentration.* **(10%)**

6. *Explain or define the following terms:*
   (a) *Quasi-Fermi energy* **(5%)**
   (b) *Flat band voltage* **(5%)**
   (c) *Lattice scattering* **(5%)**

7. *If temperature is increased about 50 degrees, how many order of current density for Si pn diode will be increased or decreased at small forward voltage ($<V_{on}$) and large forward biases ($\geqq V_{on}$), respectively? Explain the reason of these changes.* **(15%)**

8. *According* $n(E) = D_C(E) f(E)$ *where* $f(E) = \dfrac{1}{1+e^{(E-E_F)/kT}} \approx e^{-(E-E_F)/kT}$, $D_C(E) = A\sqrt{E-E_C}$ *and* $A = \dfrac{4\pi(2m_n^*)^{3/2}}{h^3}$, *find the energy E with maximum value of n(E). (Hint: the maximum value is occurred at dn(E)/dE =0.)* **(20%)**