系所組別： 微電子工程研究所

考試科目： 固態電子元件

考試日期：0220，節次：2

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

1. (15%) The structure of Si and GaAs are diamond structure, calculate the densities (g/cm^3) of Si and GaAs from lattice constant, atomic weight and Avogadro's number.

   Note: lattice constant for Si = 5.43 Å, GaAs = 5.65 Å

   Atomic weight Si = 28.1, Ga=69.7, As=74.9 g/mole

   Avogadro's number 6.02×10^{23} atoms/mole

2. (15%)

   (a) What is the Fermi energy? Consider Fermi energy for copper at T=300 K is 7.0 eV. The electrons in copper follow the Fermi Dirac distribution.

   (b) Find the probability of an energy level at 7.15 eV being occupied by an electron.

   (c) Determine the probability of the energy state at $E=E_F$ being occupied at T=1000 K.

3. (20%) For a p type cubic material experienced an + x direction magnetic field B, there is a current I (in + y direction) flow through the material. The length of each side of the cubic is L.

   (a) Explain both electron and hole's movement and accumulation (where) in details

   (b) Explain how the electric (Hall) field is induced and in what direction?

   (c) What material properties can be measured by Hall effect measurement?

   (d) For Hall measurement on polycrystalline materials, what factor could possibly affect the measurement accuracy?

4. (25%) Assume the space charge region abruptly terminates in the *n*-region at $x = -x_n$ (x_n is a positive parameter) and also abruptly terminates in the *p*-region at $x = +x_p$, please derive the expressions for the electric field in the *n*-region ($-x_n \le x \le 0$) and also the electric field in the *p*-region ($0 \le x \le x_p$).

5. (15%) Please draw the ideal energy-band diagrams for *nP* and *nN* heterojunctions in thermal equilibrium (a lowercase letter refers to a region with narrow-bandgap, whereas an uppercase letter refers to a region with wide-gap).

6. (10%) A solar cell is fabricated using GaN ($n = 2.35$) as light-absorbing material. In order to implement a single-layer antireflection coating (ARC) on the GaN solar cell, what would be the value of reflective index *n* required for this ARC layer? What would be the closest ARC material that you can choose?