**BECE201L Electronic Materials and Devices F1+TF1 slot WS 2021-22**

## Assignment 1

1. The Fermi energy level for a particular material at $T$ = 300 K is 5.50eV. The electrons in this material follow the Fermi–Dirac distribution function. (*a*) Find the probability of an electron occupying an energy at 5.80eV. (*b*) Repeat part (*a*) if the temperature is increased to $T$ = 700 K. (Assume that $E_F$ is a constant.) (*c*) Determine the temperature at which there is a 2 percent probability that a state 0.25 eV below the Fermi level will be empty of an electron.
   ***NEAMEN PG 103***
   ***SOLUTIONS PG 31***
2. Determine the probability that a quantum state at energy $E = E_c + kT$ is occupied by an electron, and calculate the electron concentration in GaAs at $T$ = 300 K if the Fermi energy level is 0.25 eV below $E_c$. At T = 300 K, $N_c$ for GaAs is $4.7 \times 10^{17}$
   ***NEAMEN PG 111***

3. Determine the thermal equilibrium electron and hole concentration in GaAs at T = 300 K for the case when the Fermi energy level is 0.30 eV above the valence-band energy $E_v$. The value of Eg is 1.42eV
   ***NEAMEN PG 113***

4. Silicon atoms, at a concentration of $7\times10^{15}$ $cm^{-3}$, are added to gallium arsenide. Assume that the silicon atoms act as fully ionized dopant atoms and that 5 percent of the concentration added replace gallium atoms and 95 percent replace arsenic atoms. Let $T$ = 300 K. (*a*) Determine the donor and acceptor concentrations. (*b*) Is the material n type or p type? (*c*) Calculate the electron and hole concentrations. (*d*) Determine the position of the Fermi level with respect to $E_{Fi}$.
   ***NEAMEN PG 154***
   ***SOLUTIONS PG 48***

5. Two semiconductor materials have exactly the same properties except material A has a bandgap energy of 0.90 eV and material B has a bandgap energy of 1.10 eV. Determine the ratio of $n_i$ of material B to that of material A for (*a*) $T$ = 200 K, (*b*) $T$ = 400 K.
   ***NEAMEN PG 150***
   ***SOLUTIONS PG 35***