COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electronics and Communications Engineering

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Course Title: Electronic Devices I

Course Code: EC 233

Cairo Branch

Sheet 3

I. Indicate whether each of the following statements is true or false *(give reasons)*:

1- The density of states at the top of the valence band is greater than zero.

2- The density of states in the valence band increases with increasing electron energy.

3- In an n-type semiconductor, the Fermi level moves closer to the middle of the energy gap as the temperature increases.

4- For temperatures greater than zero, the probability that an electron may occupy an allowed state at the Fermi level is dependent on temperature.

5- For semiconductors, the area under the energy distribution curve for the conduction band represents the total number of free electrons per cubic meter at a certain temperature.

6- The mass action law ($np = n_i^2$) is valid at thermal equilibrium in intrinsic semiconductor only.

II. Choose the correct answer justifying your choice:

1- If the density of available quantum states is G at an energy level 0.01 eV above the bottom of the edge of conduction band, this density will be ……….. at an energy level 0.04 eV above the bottom of the edge of conduction band.

   (a) 0.0016 G   (b) 4 G   (c) 0.2 G   (d) 2 G   (e) 0.02 G

2- The density of available quantum states for electrons at an energy ΔE above the bottom of the conduction band is ………… that for holes at an energy ΔE below the top of the edge of valence band in silicon

   (a) higher than   (b) less than   (c) equal to   (d) not related to

3- If E_F is the fermi energy, the probability that the the level $E_f + E$ is empty is ……… the probability that the level $E_f – E$ is occupied
   (a) higher than   (b) less than   (c) equal to   (d) not related to

III. Solve the following problems:

1- Determine the total number of energy states in GaAs between E_c and $E_c + kT$ at $T = 300$ K.

2- (a) Determine the probability that an energy level is occupied by an electron if the state is above the fermi level by (i) kT , (ii) 5kT , (iii) 10kT.

(b) Determine the probability that an energy level is empty of an electron if the state is below the fermi level by (i) kT , (ii) 5kT , (iii) 10kT.

3- Calculate the temperature at which there is a 10^{-6} probability that an energy state 0.55 eV above the Fermi energy level is occupied by an electron.

4- Calculate the energy relative to the Fermi energy for which the Fermi function equals 5%. Write the answer in units of *kT*.

Good Luck ☺