Faculty of Engineering – Shoubra Department: **Electrical Eng.** Semester: **Fall 2015 [Nov 8th 2015]**		**Course: ECE 111:** **Electronic Engineering Fundamentals** **Instructor**: **Dr.** Abdallah Hammad
Total Grade: **25**	**Mid Term Exam**	Number of questions: **4** - Time allowed: **90 Mins**

$K=1.38\times10^{-23}$ J/K	$h=6.64\times10^{-34}$ J.s	$q=1.6\times10^{-19}$ C	$m_o=9.1\times10^{-31}$ Kg	$\varepsilon_o=8.85\times10^{-14}$ F/cm
[Si] $n_i=1.5\times10^{10}$ cm^{-3}	[Si] ε_{rs}= 11.7	[Si] E_g=1.12 eV	[Ge] $n_i=2\times10^{12}$ cm^{-3}	

اسم الطالب: ..... **سكشن:** ..... **الدرجة:**

Question 1 (5 marks)

For the following statements, mark (√) for true statement and (X) for wrong statement

1	Fermi level is located above the intrinsic level in n-type Si and below it in p-type Si.	( )
2	In n-type Si, as doping concentration increases, Fermi level moves toward the conduction band edge.	( )
3	For the same doping level, the conductivity of the p-type Si is higher than that of n-type Si.	( )
4	Holes move in the opposite direction of the applied electric field.	( )
5	Drift current arises when there is a change in carrier concentration.	( )
6	The intrinsic carrier concentration of a semiconductor decreases as its energy gap increases.	( )
7	The mass action law is valid at thermal equilibrium in intrinsic semiconductors only	( )
8	When an intrinsic semiconductor is doped with N_D donors, the new electron concentration is: $n = n_i + N_D$	( )
9	The depletion region in the pn junction is depleted of immobile charges	( )
10	As the time between collisions increases, the mobility decreases	( )

Question 2 (7 marks)

i. Calculate the probability that a hole is existed at energy level 2KT below the Fermi energy level at T= 300 K.

ii. For gallium arsenide (GaAs) semiconductor, The values of the effective density of states of electrons in the conduction band and the effective density of sates of holes in the valance band at 300 K are $4.7\times10^{17}cm^{-3}$ and 7.0×10^{18} cm^{-3}, respectively and the band-gap energy is 1.42 eV. Calculate the intrinsic carrier concentration at T = 300 K and at T = 400° K.
(Assume that the energy gap is independent of temperature)

Question 3 (6 marks)

The hole concentration is given by $p(x) = 10^{15}e^{-x/L_p}$ cm^{-3} and the electron concentration is given by $n(x) = 5\times10^{14}e^{-x/L_n}$ cm^{-3}.The values of L_p and L_n and are 5 x 10^{-4} cm and 10^{-3} cm, respectively. The hole and electron diffusion coefficients are 10 cm^2/s and 25 cm^2/s respectively. The total current density is defined as the sum of the hole diffusion current density at x= 0 and the electron diffusion current density at x = 0. Calculate the total current density

Question 4 (7 marks)

i. You are given a certain n type semiconductor in the shape of a cuboid of Length L, width W, and thickness d. Explain mathematically (with a help of sketch) how you can measure the majority carrier concentration and majority carrier mobility experimentally.

ii. A semiconductor Hall device at T = 300 K has the following geometry: d =10^{-3} cm, W = 10^{-2} cm, and L= 10^{-1} cm. The following parameters are measured: I_X = 0.50 mA, V_X = 15 V, V_H = 5.2 mV, and B_Z = 0.10 Tesla. Determine the (a) conductivity type, (b) majority carrier concentration, and (c) majority carrier mobility.

Good Luck

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2	In n-type Si, as doping concentration increases, Fermi level moves toward the valance band edge.	( )
3	For the same doping level, the conductivity of the n-type Si is higher than that of p-type Si.	( )
4	Holes move in the same direction of the applied electric field.	( )
5	Diffusion current arises when there is a change in carrier concentration.	( )
6	The intrinsic carrier concentration of a semiconductor increases as its energy gap increases.	( )
7	The mass action law is valid at thermal equilibrium in intrinsic semiconductors.	( )
8	When an intrinsic semiconductor is doped with N_D donors, the new electron concentration is: $n = p + N_D$	( )
9	The depletion region in the pn junction is depleted of mobile charges	( )
10	As the time between collisions decreases, the mobility decreases	( )

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i. Calculate the probability that an electron is existed at energy level 2KT below the Fermi energy level at T= 300 K.

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