Birla Institute of Technology and Science, Pilani-Rajasthan
1st Semester 2016-2017
EEE F214/INSTR F214
Electronic Devices
Mid Semester Examination
Date: 05/10/2016 **Closed Book 90 minutes** **Max Marks:100**

Note: Use following data if not given in a problem.
ε_o = 8.85x10^{-14}F/cm, ε_r (Si) =11.8,at room temperature for Si [μ_n=1350cm^2/V·S, μ_p=480 cm^2/V·S, k= 8.62 x10^{-5} eV/K, n_i=1.5x10^{10}/cm^3, τ_n= τ_p= 1μs], kT=0.026eV at room temp.

Q1: (a) A metal has density of state distribution N(E) dE= 6.8×10^{21} $E^{1/2}$ dE, where E is measured from the bottom of the band. If the number of electrons in energy interval between E_1=4.6 eV and E_2=4.601 is 2×10^{15} cm^{-3} . Then find

(i) fraction of energy states occupied by electron in the given energy range.
(ii) position of fermi level with respect to bottom of the band.
(iii) the number of electrons between given state at 0 K. **(13)**

(b) A silicon sample is illuminated with a flash at t=0 under low level condition and its quasi Fermi levels are shown in fig. 1 at t=0^+ (τ_n=τ_p=1 μs), find **(12)**

(i) Doping concentration and type of dopant.
(ii) Excess carrier concentration.
(iii) Quasi Fermi level at the 3 μs and also at 1 ms.

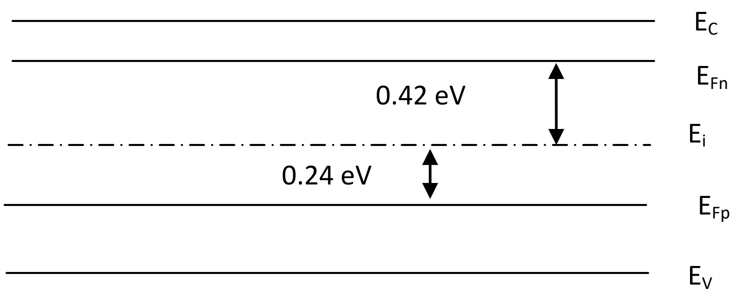

Fig. 1

Q2:(a) Sketch (qualitatively) but label at marked points in the energy band diagram indicating E_C, E_F, E_i and E_V for the silicon sample having doping profile given below: **(12)**

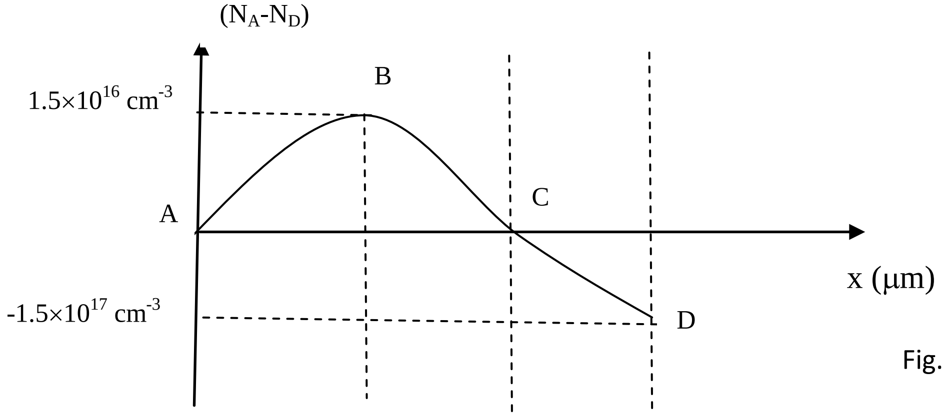

Fig. 2

(b) A silicon sample is tested in the lab and Hall coefficient has been found as +6.25 cm^3/C. The same sample is used to make a p-n junction and the a plot of 1/C^2 verses reverse voltage (V_r) is plotted to give a slope of 1/(2.88 pF)^2 . V. (Area=10^{-4} cm^2) **(13)**

(i) Find the junction potential.
(ii) Find the junction capacitance at unbiased condition.
(iii) Dopant type and concentration on n and p side.

Q3: (a) Sketch and label energy band diagram across Ge and GaAs hetero-junction if Ge is doped with **2.4×10^{18}** cm^{-3} donor atoms and GaAs is doped with $1.8\times10^{11}cm^{-3}$ acceptor atoms. **(12)**

	n_i (cm^{-3})	E_G (eV)	$q\chi$ (eV)
Ge	2.4×10^{13}	0.66	4.13
GaAs	1.8×10^{6}	1.42	4.07

(b) A p-type silicon substrate is used to make a p-n junction. It is found that across the junction the depletion charge densities comes out as $-2.4\times10^{-4}C/cm^3$ and $+2.4\times10^{-2}C/cm^3$. Area of cross-section of the junction is $10^{-4}cm^2$. Now sketch and label the following **(13)**

(i) Majority and minority carrier distribution across the junction without external bias (marking depletion width also).

(ii) Majority and minority carrier distribution across the junction at 0.5V forward bias.

(iii) Current through the diode at +0.5V.

(iv) Conductance of the forward bias diode at +0.5V.

Q4: (a) Energy band diagram of a semiconductor p-n junction diode is given in fig.3. This is designed using a p-type substrate in the beginning. Find **(15)**

(i) Initial type of dopant and their concentration.

(ii) Type of dopant required and its concentration to develop the desired pn junction.

(iii) Junction capacitance per unit area for a reverse bias voltage of 2V.

(Physical interface of p-n material is at distance 'x')

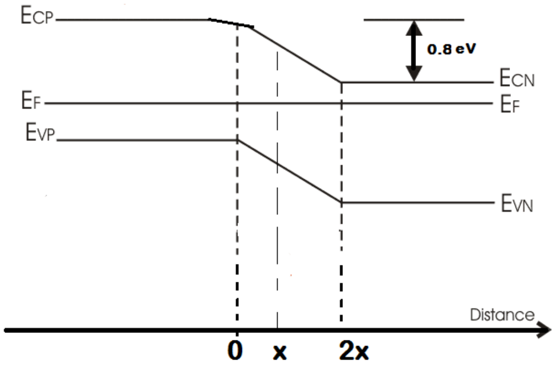

Fig. 3

(b) What happens to the following parameters if the temperature increases. Comment in terms of Increases/ Decreases /doesn't change . **(10)**

(i) Band-gap

(ii) Impurity scattering based mobility

(iii) Wave vector of conductive electron.

(iv) Minority carrier in the semiconductor.

(v) Majority carrier in doped semiconductor.

(vi) Junction capacitance of a p-n junction.

(vii) Cut-in potential of pn junction.

(viii) Breakdown voltage (Zener Breakdown)

(ix) Reverse saturation current.

(x) Diode current

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