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UNIVERSITY OF ENERGY AND NATURAL RESOURCES, SUNYANI, GHANA

SCHOOL OF ENGINEERING

DEPARTMENT OF COMPUTER AND ELECTRICAL ENGINEERING

LEVEL 200 MID SEMESTER EXAMINATION 2017/2018

Bachelor of Science (Electrical, Computer and Renewable Energy Engineering)

CENG 207: SOLID STATE DEVICES

Attempt all Questions

October, 2017 Time: 60 Mins

Question 1 [2+6+2]

An abrupt Si p-n junction has $N_D = 1 \times 10^{14} cm^{-3}$ on one side and $N_A = 1 \times 10^{17} cm^{-3}$ on the other.

a) Calculate the fermi level positions at 300K in the p and n regions
b) Draw an equilibrium band diagram for the junction and determine the contact potential from the diagram
c) Calculate the depletion width, W and the depletion in the p and n regions

Question 2 [4+6]

(a) A Si bar 0.1μm long and 100μm^2 in cross-sectional area is doped with $10^{17} cm^{-3}$ phosphorus. $[\mu_n = 1350 m^2/V - s]$. Find the current at 300k with 10 V across it.

(b) A GaAs LED has a doping profile of $N_A = 10^{14} cm^{-3}$ and $N_D = 10^{15} cm^{-3}$. The minority carrier time, $\tau_n = 10^{-8} s; \tau_p = 7 \times 10^{-9} s$. The electron diffusion coefficient is $100 cm^2 s^{-1}$ while that of the hole is $20 cm^2 s^{-1}$. Calculate the ratio of electron injected current across the junction to the total current. $[n_i(GaAs) = 1.8 \times 10^6]$

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PHYSICAL CONSTANTS

q	Electronic Charge	1.602×10^{-19}	C		
ε_o	Permittivity of Free Space	8.854×10^{-14}	$F.cm^{-1}$		
μ_o	Permeability of Free Space	1.2566×10^{-8}	$H.cm^{-1}$		
k	Boltzmann Constant	1.38×10^{-23}	$J.K^{-1}$	8.62×10^{-5}	$eV.K^{-1}$
h	Planck Constant	6.626×10^{-34}	J.s		
m_o	Electron Rest Mass	9.11×10^{-31}	kg		
eV	Electron Volt	1.602×10^{-19}	J		
c	Speed of Light	3×10^{8}	$m.s^{-1}$		
kT/q	Thermal Voltage (290K)	0.0259 V			

SOME PROPERTIES OF SILICON

n_i	Intrinsic Carrier Concentration	1.5×10^{10}	cm^{-3}
N_C	Effective Density of States (CB)	2.8×10^{19}	cm^{-3}
N_V	Effective Density of States (VB)	1.04×10^{19}	cm^{-3}
E_G	Band Gap	1.12	eV
ε_s	Dielectric Constant	11.8	
ε_{ox}	Dielectric Constant	3.6	
χ	Electron affinity (Si)	4.05	V

1.22×10^{-8}