UNIVERSITY OF ENERGY AND NATURAL RESOURCES, SUNYANI, GHANA
SCHOOL OF ENGINEERING
DEPARTMENT OF COMPUTER AND ELECTRICAL ENGINEERING
Level 200 End of First Semester Examinations 2020/2021
Bachelor of Science (Electrical & Electronic Engineering)
Bachelor of Science (Computer Engineering)
Bachelor of Science (Renewable Energy Engineering)

CENG 207: SOLID STATE ELECTRONIC DEVICES

April, 2021 Time: 2½ hours

Instructions: Attempt **Section A** on the question paper and **Section B** in the Answer Booklet
Material required: Class material / Hand-out (**To be brought in by students- Useful data can be found on page 3)**

Section A

1. In which quadrant of the junction I-V characteristics will a solar cell operate?

2. A 2V cell is applied across an n-type silicon sample of length 1cm. If the drift velocity of an electron in the sample is 3800 cm/s, calculate the diffusion coefficient of the sample.

3. What is the diffusion current density in a silicon sample whose hole density changes uniformly from 2x1017cm-3 to 1.2x1011cm-3 in a distance of 12μm?

4. A metal-insulator-semiconductor is realized using a metal of work function 4.85eV, SiO2 as insulator and silicon doped with 3x1018cm-3 donor impurities as the semiconductor. Estimate the flat band voltage VFB.

5. A holes in a Si sample undergoes collision for an average time of 2.5p.s. If the hole is subjec to a field of E= 103 V/cm and has a mobility of 4.70cm2/V.s. Find the distance travelled.

6. A Si sample is doped with 2 x 1017 Arsenic atoms/cm3. Calculate the equilibrium hole concentration p_o at 300K

191

Scanned with CamScanner

7. Find the resistivity of intrinsic Silicon at 300K [μn=1250 cm2/Vs; μp=480cm2/Vs]

8. The same Si sample (question 6) is further doped with 7 x1015cm-3 acceptors. What type of extrinsic material?

9. An npn transistor is biased in the forward active mode. The base current I_B =9.6μA and the emitter current I_E =0.780mA. Find β and the collector current I_C

10. Name any two types of PNPN devices.

Section B: Answer in the Answer BOOKLET

Question 1[5 x 2 = 10]

A 10kΩ resistor is to be designed to handle a current density of 50A/cm^2 when a 5V is applied. If this resistor is limited to electric field of E =100 V/cm and is made of p-type Silicon material with μ= 410 cm^2/V-s, calculate:

i current passing through the resistor
ii cross-sectional area
iii length of the resistor
iv conductivity
v concentration

Question 2 [2 x 10 =20]

(a) Consider a uniformly doped silicon bipolar transistor at T=300K with a base doping of N_B =5 x 10^{16} cm^{-3} and collector doping of N_C =2 x 10^{15} cm^{-3}. Assume the metallurgical base width is 0.70μm. Calculate the percentage change in neutral base width as the C-B voltage changes from 2 to 10 V.

(b) The electron concentration in silicon is given by $n(x) = 10^{15}e^{-(x/L_n)}$ cm^{-3} (x≥0), where L_n = 10^{-4} cm. The electron diffusion coefficient is D_n = 25 cm^2/s. Determine the electron diffusion current density at x = 0.

Question 3 [2 x 5 = 10]

a) Distinguish between an Enhancement and Depletion MOSFETs with diagrams
b) State the difference between a PN junction diode and a Scottky diode
c) What is a degenerative semiconductor?
d) Distinguish between a Bipolar transistor and Junction Field Effect transistor with diagrams.
e) Using the I-V characteristics of a p-n junction under various levels illumination, explain the photoconductive and photovoltaic effects.

Scanned with CamScanner

PHYSICAL CONSTANTS

	Electronic Charge	1.602×10^{-19}	C		
q	Permittivity of Free Space	8.854×10^{-14}	$F.cm^{-1}$		
ε_o	Permeability of Free Space	1.2566×10^{-8}	$H.cm^{-1}$		
μ_o	Boltzmann Constant	1.38×10^{-23}	$J.K^{-1}$	8.62×10^{-5}	$eV.K^{-1}$
k	Planck Constant	6.626×10^{-34}	J.s		
h	Electron Rest Mass	9.11×10^{-31}	kg		
m_o	Electron Volt	1.602×10^{-19}	J		
eV	Speed of Light	3×10^{8}	$m.s^{-1}$		
c	Thermal Voltage (300K)	0.025	V		
kT/q					

SOME PROPERTIES OF SILICON

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

Scanned with CamScanner