

UNIVERSITY OF ENERGY AND NATURAL RESOURCES, SUNYANI, GHANA SCHOOL OF ENGINEERING

DEPARTMENT OF COMPUTER AND ELECTRICAL ENGINEERING

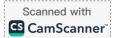
Level 200 End of First Semester Examinations 2020/2021
Bachelor of Science (Electrical & Electronic Engineering)
Bachelor of Science (Computer Engineering)
Bachelor of Science (Renewable Energy Engineering)

CENG 207: SOLID STATE ELECTRONIC DEVICES

Time: 21/2 hours April, 2021 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 subject to a field of E= 103 V/cm and has a mobility of 4.70cm2/V.s. Find the distance travelled. 5. A Si sample is doped with 2 x 1017 Arsenic atoms/cm3. Calculate the equilibrium hole concentration po at 300K

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K. Diawuo



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7.	Find the resistivity of intrinsic Silicon at 300K [µn=	-1250 cm2/Vs; μp=4	80cm2/Vs]
8.	The same Si sample (question 6) is further doped we extrinsic material?	ith 7 x1015cm-3 acc	eptors. What type of
9.	An npn transistor is biased in the forward active momentum current I_E =0.780mA. Find β and the collection		$I_B = 9.6 \mu A$ and the
		DUOCHES III	Lumi mi
10	. Name any two types of PNPN devices.	West of acres	0.120.10.10
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Section B: Answer in the Answer BOOKLET

Question $1[5 \times 2 = 10]$

A $10k\Omega$ 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 cm²/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 $N_B = 5 \text{ x}$ 10^{16} cm^{-3} and collector doping of $N_C = 2 \text{ x}$ 10^{15} cm^{-3} . Assume the metallurgical base width is 0.70 μ m. 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 $D_n = 25$ cm²/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.

K. Diawuo

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PHYSICAL CONSTANTS

	Electronic Charge	1.602 x 10 ⁻¹⁹	С		
9	Permittivity of Free Space	8.854×10^{-14}	F.cm ⁻¹		
80	Permeability of Free Space	1.2566 x 10 ⁻⁸	H.cm ⁻¹		- 1 - 1 - 1
μο	Boltzmann Constant	1.38×10^{-23}	J.K-1	8.62 x 10 ⁻⁵	eV.K-1
K	Planck Constant	6.626×10^{-34}	J.s		
h	Electron Rest Mass	9.11×10^{-31}	kg		
mo	Electron Volt	1.602 x 10 ⁻¹⁹	J	Programme and the second	
eV	Speed of Light	3 x 10 ⁸	m.s ⁻¹		
c vT/a	Thermal Voltage (300K)	0.025	. V	2	

SOME PROPERTIES OF SILICON

Intrinsic Carrier Concentration	1.5×10^{10}	cm ⁻³
Effective Density of States (CB)	2.8×10^{19}	cm ⁻³
Effective Density of States (VB)	1.04 x 10 ¹⁹	cm ⁻³
Band Gap	1.12	eV
Dielectric Constant	11.8	•
Dielectric Constant	3.6	
Electron affinity (Si)	4.05	V