FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI
ELECTRICAL/ELECTRONIC ENGINEERING DEPARTMENT
2016/2017 HARMATTAN SEMESTER EXAMINATIONS TIME: 3 Hours

ECE 405: SEMICONDUCTOR DEVICES TECHNOLOGY

INSTRUCTIONS: ANSWER ANY FIVE QUESTIONS (EACH QUESTION CARRIES 20 MARKS).

QUESTION 1

a) Describe substitutional diffusion and interstitial diffusion stating the equations of their frequencies of diffusion. (6 marks)
b) State Fick's 1st law with regards to diffusion and state its limitations. (5 marks)
c) Outline the five benefits of Integrated circuit components over discrete component. (5 marks)
d) Explain with five examples of each category, the difference between discrete and integrated circuits. (4 marks)

QUESTION 2

a) Explain with examples the difference between the following pairs: i). element and compound semiconductors. ii). intrinsic and extrinsic semiconductors. iii). LEDs and Lasers. iv). Conductivity in copper and silicon. (12 marks)
b) The required dose (Q) for a drive-in step of a **limited source** diffusion is 6.025×10^{13} atoms/cm^2. Determine the Boron surface concentration given the diffusion co-efficient of 1.55×10^{-16} cm^2/sec at 1200°C and time of 50 seconds. (8 marks)

QUESTION 3

a) Describe with an appropriate diagram one known method of producing monocrystalline silicon. (5 marks)
b) Outline three reasons why silicon is mostly used for IC fabrication and list two other useful materials (5 marks)
c) Define epitaxy and state its function in IC fabrication. (5 marks)
d) All microelectronic device fabrication happen in Clean rooms. Why? Outline cleanroom etiquettes for IC fabrication workers. (5 marks)

QUESTION 4

a) State the primary uses of silicon dioxide in IC fabrication and why silicon dioxide is preferred. (5 marks)
b) Describe thermal oxidation stating types and equations that represent the types of thermal oxidation. (5 marks)
c) Given that the body of a resistor is five squares long. If the sheet resistance, Rs is 200Ω/ square and each contact adds 0.75 squares. Find resistance of the diffused resistor. (5 marks)
d) Calculate the barrier potential at room temperature for silicon p-n junction which is doped to carrier density of 10^{20}m^{-3} on the p-side and 10^{21}m^{-3} on the n-side. The intrinsic carrier density for Silicon is 1.4×10^{16}m^{-3}. Assume V_T is 26mV. (5 marks)

QUESTION 5

a) Sketch the energy band diagram of an n-type semiconductor showing clearly the donor level, Fermi level, the valence and the conduction bands. (6 marks)
b) The Fermi level of an intrinsic semiconductor is given by: $Ef = \frac{E_C + E_V}{2}$. Prove this. (6 marks)
c) Outline the difference between SIEMENS method and Fluidized bed deposition reactor method of procuring semiconductor grade silicon. (8marks)

QUESTION 6

a) Give two examples of donor and acceptor elements used in diffusion, why is aluminum not used as an acceptor? (6 marks)
b) Outline the importance of diffusion and the difference between Limited source and Constant source diffusion. (8 marks)
c) Describe with the aid of a simple diagram, the process flow for IC manufacturing from silica to packaging. (6 marks)

QUESTION 7

a) Illustrate with energy band diagrams what distinguishes conductors from semiconductors. (6 marks)
b) Outline Fermi level equation and state its relevance in semiconductor theory. (6 marks)
c) In about 4 sentences each, describe the following: i) n-type semiconductors. ii) p-type semiconductors iii) Ion implantation iv) Sputtering. (8 marks)