KIMATHI UNIVERSITY COLLEGE OF TECHNOLOGY

UNIVERSITY EXAMINATIONS 2015/2016 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN

TELECOMMUNICATION AND INFORMATION ENGINEERING

TIE 2402: INTEGRATED CIRCUITS TECHNOLOGY

SUPPLEMENTAL EXAM

Do question 1 and any other 2 questions

1. An ion implanter is a high-voltage particle accelerator producing a high-velocity beam of impurity ions which can penetrate the surface of silicon target wafers.
   A. Draw a schematic diagram of an Implanter and clearly label the five major stages of the Implanter (10 points)
   B. Describe the Target Chamber (3 points)
   C. Describe the Mass Spectrometer (3 points)
   D. Explain how an Ion Source works. (3 points)
   E. Phosphorus with energy of 100 keV is implanted into a silicon wafer. The range and straggle of the beam is 0.12 μm and 0.045μm respectively. What should be the implanted dose be if the peak concentration of $N_p = 1 \times 10^{17} cm^{-3}$ is desired? (9 points)
2. Boron has diffusion coefficient $D_0 = 10.5\ cm^2/sec$ and activation energy $E_A = 3.69\ eV$.
   A. Calculate the diffusion coefficient for boron at 1100 °C (5 points)

   B. A boron diffusion is used to form the base region of an npn transistor a 0.18-ohn-cm n-type silicon wafer. A solid-solubility-limited boron predeposition is performed at 900 C for 15 minutes followed a 5-hr drive –in at 1100C. If the Surface concentration is given at $1.1 \times 10^{20}/cm^3$, write an expression for the impurity profile following the predeposition. (5 points)
   C. Using the information given in B above and given that the background doping concentration is $3 \times 10^{16}/cm^3$, Find the junction depth x_j . (5 points)

   D. Using information provided in B and C above, find the concentration and the junction depth after the drive-in step (10 points)

3. For a bipolar transistor with the following parameters: $W_B = 1\mu m, \eta = 10, D_B = 20\ cm^2/sec, C_{JC} + C_{Sub} = 2\ pF, r_c = 250\ Ohms, X_C = 10\mu m$ and $V_S = 10^7 cm/sec$ Calculate the

   (A) transit time

(B) Unity gain frequency

4. An IC diode is designed to have a room-temperature saturation current of $I_0 = 5 \times 10^{-17}$A. The diode has the following device properties: $W_p = 0.5\mu m$, $W_n=1.0\mu m$, $N_a = 2.5 \times 10^{17} cm^{-3}$, $N_d = 4.0 \times 10^{16}$ cm^{-3}, $D_n = 5$ cm^2/s and $D_p = 5$ cm_2/s. If the diode has a bias voltage of V_D=720mV

A. What is the small signal resistance? (5 points)

B. Find the depletion (10 points)

C. What is the minority carrier concentration on p-side of the diode? (10points)