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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017
Course Code: EC203
Course Name: SOLID STATE DEVICES (EC, AE)

Max. Marks: 100   Duration: 3 Hours

PART A
Answer any two full questions, each carries 15 marks.
Marks

1 a) Derive the expression for electron, hole and intrinsic concentrations at equilibrium in terms of effective density of states. Formulate the relation between these concentrations at equilibrium.   (8)

   b) A Silicon sample is doped with 10^{17} boron atoms/cm^3. What is the equilibrium electron and hole concentrations at 300K? Where is E_F relative to E_i. Draw the energy band diagram. Intrinsic carrier concentration of Silicon is 1.5 x 10^{10} at 300K.   (7)

2 a) A Silicon bar of 100 cm long and 1 cm^2 cross sectional area is doped with 10^{17}Arsenic atoms/cm^3. Calculate electron and hole concentrations at 300K. Also find the conductivity and the current with 10V applied. Electron mobility at this doping is 700 cm^2/V-sec.   (7)

   b) What is Hall effect? Derive the expression for carrier concentration and mobility in terms of Hall voltage.   (8)

3 a) Describe diffusion process. Derive the expression for diffusion current density.   (7)

   b) Prove that under steady state carrier injection, the injected excess carrier concentration is an exponentially decreasing function of distance.   (8)

PART B
Answer any two full questions, each carries 15 marks.

4 a) Draw the energy band diagram of a PN junction   (6)
     i) at equilibrium,   ii) under forward bias and iii) under reverse bias.

   b) A Silicon sample having circular cross section with diameter 10μm is doped with 10^{18} cm^{-3} acceptor impurities on one side and 5x10^{15} cm^{-3} donor impurities on the other side. If the sample is at equilibrium, calculate contact potential, width of depletion region, penetration of depletion region on both N side and P side, and total charge on both N side and P side at 300K.   (9)

5 a) An abrupt Silicon PN junction has the following parameters at 300K.   (10)
     P side:- Na=10^{17} cm^{-3}, τ_n=0.145, μ_n= 700 cm^2/V-sec.
     N side:-N_d=10^{15} cm^{-3}, τ_p=1045, μ_p= 450 cm^2/V-sec.
     The junction is forward biased by 0.5V. What is the forward current. What is the current at reverse bias of (-0.5V).

   b) Differentiate between ohmic and rectifying contacts.   (5)

6 a) Derive the expression for depletion and diffusion capacitance of a PN junction.   (7)

   b) With the help of necessary diagrams, explain the working of a tunnel diode.   (8)

PART C
Answer any two full questions, each carries 20 marks.

7   a)   Derive the expression for minority carrier distribution and terminal currents in a   (12)
         transistor.

    b)   Describe early effect in a transistor.   (5)

    c)   What are the factors which cause base current in a transistor?   (3)

8   a)   With the help of necessary band diagrams, explain equilibrium, accumulation,   (12)
         depletion and inversion stages of a MOS capacitor.

    b)   What are the effect of real surfaces of a MOS capacitor.   (4)

    c)   Draw and explain the structure of FINFET.   (4)

9   a)   Derive the expression for drain current of a MOSFET.   (10)

    b)   Draw and explain the transfer characteristics of an n-channel MOSFET.   (5)

    c)   A Silicon n-channel MOSFET has μ_n= 600 cm^2/V-sec, C_{ox}= 1.2x10^{17} F/cm^2, z=50   (5)
         μm, L=10 μm and V_{TH}= 0.8V. Find he drain current when

         i) V_{GS}=2V and V_{DS}=1V   ii) V_{GS}=3V and V_{DS}=5V

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