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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S3 (S,FE) / S1 (PT) (S,FE) Examination June 2024 (2015 Scheme)

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) Explain Fermi Dirac distribution function. Plot the Fermi Dirac distribution function for intrinsic and extrinsic semiconductors. (8)

b) What is Einstein Relation? Derive the expression. (7)

2 a) An unknown semiconductor has Eg = 1.1 eV and Nc = Nv. It is doped with 10^{15} cm^{-3} donors, where the donor level is 0.2 eV below Ec. Given that E_F is 0.25 eV below Ec, calculate ni and the concentration of electrons and holes in the semiconductor at 300K. (8)

b) Explain diffusion process in a semiconductor and derive the expression for diffusion current density. (7)

3 a) Define Hall effect. Derive the expression for mobility and carrier concentration in terms of Hall voltage. (8)

b) Prove that under steady state carrier injection, the injected excess carrier concentration is an exponentially decreasing function of distance. (7)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive the expression for contact potential and depletion region width of an abrupt PN junction at equilibrium. (9)

b) Distinguish between Zener and Avalanche breakdown mechanisms. (6)

5 a) Draw the distribution of charge carriers, potential, electric field and charge density within the transition region of an abrupt pn junction. (9)

b) A silicon abrupt p-n junction at 300K has $N_A = 10^{16}$ cm^{-3} on p-side and $N_D = 10^{14}$ cm^{-3} on n-side. Area of cross-section is 10^{-5} cm^2. Calculate the junction capacitance at equilibrium. Assume ni for silicon at 300K as 1.5×10^{10} cm^{-3} (6)

6 a) Derive Ideal Diode equation and list the assumptions. (9)

b) With the help of energy band diagrams, explain metal- n type Schottky contact. (6)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Illustrate the minority carrier distribution in a PNP transistor. Plot and mark the minority carrier concentrations in the three regions. (10)

b) Draw and explain the structure of FinFET (5)

c) Draw and explain the transfer characteristics of an enhancement type MOSFET (5)

8 a) Explain Early effect. What is its effects on I_c, I_B, α and β of a transistor? (5)

b) Define the basic performance parameters of BJTs. (5)

c) With the help of necessary band diagrams, explain equilibrium, accumulation, depletion and inversion stages of a MOS capacitor. (10)

9 a) For a pnp BJT with $N_E < N_B < N_C$, if $I_{Ep} = 10$ mA, $I_{En} = 100$ μA, $I_{Cp} = 9.8$ mA and $I_{Cn} = 1$ μA, calculate the base transport factor and emitter injection efficiency. (5)

b) Draw the structure of a PNP transistor and explain the flow of different current components in a pnp transistor under active mode of operation. (5)

c) Draw and explain the C-V Characteristics of an Ideal MOS capacitor. Derive the expression for threshold voltage. (10)

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