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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

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) Calculate the thermal equilibrium electron and hole concentration in silicon at $T=300K$, when the Fermi energy level is 0.27 eV below the conduction band edge E_C. The effective densities of states in the conduction band and valence band are 2.8×10^{19} cm^{-3} and 1.04×10^{19} cm^{-3} respectively at 300K. (5)

b) Explain the effect of temperature on mobility. (3)

c) Derive an expression for drift current density in a semiconductor. (7)

2 a) A silicon sample doped with 10^{16}cm^{-3} donors at 300K is optically excited such that the optical generation rate is 10^{20} EHP/(cm^{3}-s). Find the separation between quasi-Fermi levels if $\tau_p = \tau_n = 2$ µs. (5)

b) How does drift velocity vary with applied electric field in a silicon semiconductor. (3)

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

3 a) Explain the temperature dependence of intrinsic carrier concentration in a semiconductor. (5)

b) Electron mobility and life time in a semiconductor at room temperature are 0.36 m^{2}/V-s and 340 µs respectively. Compute the electron diffusion length. (3)

c) Derive the steady-state diffusion equations in semiconductors. (7)

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

4 a) Draw the energy band diagram of a p-n junction under: (6)
i) Equilibrium ii) Forward biased condition iii) Reverse biased condition.

b) Derive the ideal diode equation and list the assumptions. (9)

5 a) Define junction capacitance. Determine the junction capacitance of a silicon p-n junction at $T=300K$ when a reverse bias voltage of 5V is applied across the junction. The doping concentrations of p and n regions are 8×10^{21}m^{-3} and 3×10^{22} m^{-3} respectively and the cross sectional area of the junction is 5×10^{-9} m^{2}. (Assume n_i for Si at 300K = 1.5×10^{16}m^{-3} and $\varepsilon_r = 11.7$) (7)

b) With suitable energy band diagrams, explain Schottky contact. (8)

6 a) Derive an expression for the open circuit contact potential V_o of a normal P-N junction diode. (5)

b) Differentiate between Zener breakdown and Avalanche breakdown. (5)

c) Prove that penetration of depletion region is more towards lightly doped side in a P-N junction diode. (5)

PART C

Answer any two full questions, each carries 20 marks

7 a) Derive an expression for emitter injection efficiency of a transistor. (10)

b) Explain early effect. (5)

c) Derive the relationship between α and β of a transistor. (5)

8 a) Explain the principle of operation of MOS capacitor with suitable energy band diagrams. (10)

b) Define threshold voltage of MOS capacitor. (3)

c) Draw and explain the C-V characteristics of a MOS capacitor. (7)

9 a) Explain the drain characteristics and transfer characteristics of an enhancement type MOSFET with suitable diagrams. (10)

b) Explain the principle of operation of FinFET. (5)

c) Draw the minority carrier distribution in a PNP transistor and explain why the minority concentration in the base region is linear. (5)

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