Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 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) Define Hall effect. Derive the expressions for majority carrier concentration and mobility. (7)

b) Explain the variation in energy levels of a semiconductor when an electric field is applied? (3)

c) Consider a semiconductor bar with w=0.1mm, t=10μm and L=5mm. For B=10kg (1kg= 10^{-5}Wb/cm^2) and a current 1mA, we have V_{AB}=-2mV, V_{CD}=100mV, Find the type, concentration, and mobility of the majority carrier. (5)

2 a) Prove that $n_0p_0 = ni^2$. (7)

b) The Fermi level position in a Si sample at 300K is 0.29eV below E_c. Determine the carrier concentration and conductivity of the specimen. Given that n_i=1.5 x 10^{10}cm^{-3}, μ_n=1350cm^2/Vs, μ_p=480cm^2/Vs. (8)

3 a) Derive an expression for drift current density. (7)

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

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

PART B

Answer any two full questions, each carries 15 marks.

4 a) Draw the energy band diagram of a p-n junction at a) equilibrium b) Forward bias c) Reverse bias. (6)

b) Differentiate Ohmic contact and Rectifying contacts with neat diagram. (9)

5 a) Explain with neat diagrams (7)

(i) Zener breakdown.

(ii) Avalanche breakdown.

b) With appropriate energy band diagram explain the operation of a tunnel diode. (8)

6 a) Determine the junction capacitance of a silicon pn junction at T = 300 K when a reverse bias voltage of 5V is applied across the junction. The doping concentrations of p&n regions are $8x10^{21}$ m^{-3}& $3x10^{22}$ m^{-3} respectively & the cross-sectional area of the junction is $5x10^{-9}$ m^2. (Assume n_i for Si at 300K is $1.5x10^{10}cm^{-3}$ and ε_r=11.7) (7)

b) Derive the expression for open circuit contact potential of a p-n junction under equilibrium. (8)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive the expression for drain current at saturation for a MOSFET. (8)

b) Explain the basic performance parameters α, β & γ. (6)

c) Explain early effect and early voltage. (6)

8 a) Derive the expression for minority carrier distribution in a pnp transistor. (10)

b) Explain the principle of operation of MOS capacitor with suitable energy band diagram. (10)

9 a) Explain the principle of operation of FINFET with neat diagrams. (5)

b) Plot the sub-threshold characteristics of MOSFET and explain. (5)

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

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