Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

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 conductivity and mobility of carriers in a semiconductor subjected to an electric field. (7)

b) Explain the temperature dependence of carrier concentration in extrinsic semiconductors. (3)

c) Calculate the hole and intrinsic carrier concentrations. Sketch band diagram. $Nc=10^{19}/cm^3$, $Nv=5x10^{18}/cm^3$, Eg=2eV, T=900K, $n_0=10^{17}/cm^3$. (5)

2 a) Derive Einstein's relation. (6)

b) Explain why indirect recombination is a slow process. (4)

c) A Si sample is doped with $10^{16}/cm^3$ In atoms and a certain number of shallow donors. The In acceptor level is 0.16eV above E_V and E_f is 0.26eV above E_V at 300K.How many In atoms are un-ionised? (5)

3 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) An n-type Si sample with *Nd* = 10^{15} cm^{-3} is steadily illuminated such that gop = 10^{21} EHP/cm^3s. If $\tau_n = \tau_p$ = lμs for this excitation, calculate the separation in the quasi-Fermi levels, *(Fn - Fp).* (7)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive ideal diode equation. State any two assumptions used. (10)

b) Draw the potential, charge density and electric field distribution within the transition region of an abrupt pn junction with Nd<Na. Label the diagram. (5)

5 a) Illustrate how a metal – n type contact behave as rectifying contact and ohmic contact with supporting energy band diagram. (10)

b) If a metal with a work function of 4.6 e V is deposited on Si (electron affinity of 4 eV) and acceptor doping level of 10^{18} cm^{-3}. Draw the equilibrium band diagram and mark off the Fermi level, the band edges, and the vacuum level. Is this a Schottky or ohmic contact, and why? (5)

6 a) Illustrate the operation of a tunnel diode with supporting diagrams and explain its VI characteristics (10)

b) An abrupt Si p-n junction has $N_a = 10^{18}cm^{-3}$ on one side and $N_d = 5x\ 10^{15}cm^{-3}$ on the other. If the junction has a circular cross section with a diameter of 10μm, Calculate Vo, x_{no} , Q_+, and Ɛo for this junction at equilibrium (300 K). (5)

PART C

Answer any two full questions, each carries20 marks.

7 a) Derive the expression for minority carrier distribution and terminal currents in a BJT. State the assumptions used. (12)

b) Explain the basic performance parameters α, β & γ. (3)

c) Assume that a p-n-p transistor is doped such that the emitter doping is 10 times that in the base, the minority carrier mobility in the emitter is one-half that in the base, and the base width is one-tenth the minority carrier diffusion length. The carrier lifetimes are equal. Calculate α and β for this transistor. (5)

8 a) Derive the expression for drain current at linear region and saturation for a MOSFET. (10)

b) An Al-gate p-channel MOS transistor is made on an n-type Si substrate with $N_d = 5x10^{17}\ cm^{-3}$. The SiO_2 thickness is 100 Å in the gate region, and the effective interface charge Q_i is 5×10^{10} q C/cm^2. Find W_m , V_{FB} , and V_T, if the gate to substrate work function difference Φms = -0.15V (5)

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

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

b) Explain base width modulation. Explain its effect on terminal currents. (5)

c) Draw and label the minority carrier distribution curve of a BJT in active mode. (5)

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