C C1115 Pages 2

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 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) Explain Fermi Dirac distribution function. Plot the Fermi Dirac distribution function for an intrinsic semiconductor. (4)

b) Explain diffusion. Derive an expression for diffusion current density for an n-type semiconductor. (7)

c) A Si sample is doped with 10^{17}As atoms/cm^3. What is the equilibrium hole concentration p_0 at 300K? Where is E_F relative to E_i? (4)

2 a) Draw the graph showing the distribution of excess carrierswith respect to time in an n-type semiconductor. (3)

b) Derive the expressions for equilibrium concentration of electrons and holes using Fermi Dirac distribution function. (6)

c) A direct bandgap semiconductor has$n_i = 10^{10}$ cm^{-3} donors. Its low level carrier lifetime τ is$\tau_n = \tau_p = 10^{-7}$s. (6)

i) If a sample of this material is uniformly exposed to a steady optical generation rate of $g_{op} = 2\text{x}10^{22}$ EHP/cm^2-s; Calculate the excess carrier concentration $\Delta_n = \Delta_p$

Note : The excitation rate is not low level but assume that α_r is the same.

ii) If the carrier lifetime (τ) is defined as the excess carrier concentration divided by the recombination rate, what is τ at this excitation level?

3 a) Explain High field effects. (4)

b) Derive and explain Einstein relations. (6)

c) A Ge sample is doped with 10^{17} Boron atoms/cm^3.Determine the carrier concentration & Fermi level position at room temperature.n_i for Ge = 2.5×10^{13} cm^{-3} at room temperature. (5)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Draw and explain the VI characteristics of PN junction diode. (4)

b) Explain the different types of capacitances associated with a p-n junction. (6)

c) The following data are given for a Si abrupt pn junction at 300k, $A=1cm^2$, $V_o=0.6V$. (5)

P- side	N-side
$N_A = 10^{18}\ cm^{-3}$	$N_D = 10^{16}\ cm^{-3}$
$\tau_n = 50\ \mu s$	$\tau_p = 10\ \mu s$
$D_n = 34\ cm^2/s$	$D_p = 13\ cm^2/s$

Calculate $I_p(x_n = 0)$; $I_n(x_p = 0)$ & the total diode current ; (Given $kT/q = 0.026$ V)

5 a) Derive the ideal diode equation. (10)

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

6 a) Derive an expression for the contact potential of an open circuit p-n junction. (7)

b) Write short notes on metal semiconductor contacts. (8)

PART C

Answer any two full questions, each carries20 marks.

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

b) Explain base width modulation with neat diagrams. (4)

c) Briefly explain (6)

i) MOSFET scaling.

ii) Hot electron effect.

8 a) Derive the expression for minority carrier distribution and terminal currents of a pnp transistor. (14)

b) Explain the capacitance – voltage relation for a MOS capacitor with neat diagram. (6)

9 a) Explain the principle of operation of FINFET. (7)

b) With neat diagrams, explain the flow of different current components in a pnp transistor under active mode of operation. (7)

c) Draw and explain the drain characteristics of an n-channel MOSFET. (6)

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