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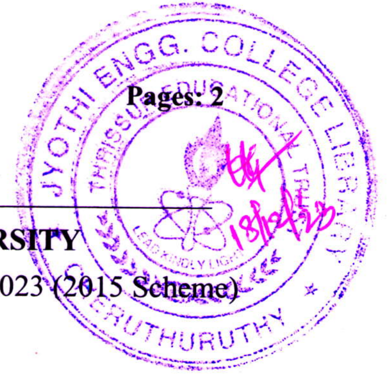

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S3 (S, FE) / S1 (PT) (S, FE) Examination December 2023 (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 the temperature dependence of carrier concentration of an extrinsic semiconductor (7)

b) A Si sample with $10^{16}/cm^3$ donors is optically excited such that $10^{19}/cm^3$ electron - hole pairs are generated per second uniformly in the sample. The laser causes the sample to heat up to 450K. Find the quasi-Fermi levels and the change in conductivity of the sample upon shining the light. Electron and hole life times are both 10 μs, Dp = 12 cm^2/s, Dn = 36 cm^2/s, ni = 10^{14} cm^{-3} at 450 K. What is the change in conductivity upon shining light? (8)

2 a) Explain the variation of mobility with temperature and doping. (7)

b) Derive the continuity equation for holes and electrons in a semiconductor. Find the expression for steady state diffusion equations for holes and electrons. (8)

3 a) Derive the expression for conductivity and mobility of carriers in a semiconductor subjected to an electric field. (7)

b) Show that diffusion length is the average distance a carrier diffuses before it recombines. (8)

PART B

Answer any two full questions, each carries 15 marks.

4 a) List the assumptions and derive Ideal Diode equation (9)

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

5 a) Boron is implanted into an n-type Si sample ($N_d = 10^{16}$ cm^{-3}), forming an abrupt junction of square cross section with area 2×10^{-3} cm^2. Assume that the acceptor concentration in the p type region is $N_a = 4 \times 10^{18}$ cm^{-3}. Calculate V_o, X_{no}, X_{po}, Q+ and E_o for this junction at equilibrium (300K). (9)

b) Explain the operation of a tunnel diode with appropriate energy band diagram. (6)

6	a)	Draw the energy band diagram of a p-n junction at a) equilibrium b) Forward bias c) Reverse bias.	(9)
	b)	With the help of energy band diagrams, explain metal- n type Ohmic contact.	(6)

PART C

Answer any two full questions, each carries 20 marks.

7	a)	Draw the minority carrier distribution in PNP transistor in saturation mode and explain.	(5)
	b)	The following parameters are given for a transistor $I_{pE} = 0.678$ mA, $I_{nE} = 2.712 \times 10^{-6}$ A, $I_{pC} = 0.6779$ mA, $I_{nC} = 9.4 \times 10^{-15}$ A. Determine emitter injection efficiency and base transport factor.	(5)
	c)	Draw and explain the C-V Characteristics of an Ideal MOS capacitor. Derive the expression for threshold voltage.	(10)
8	a)	Define the basic performance parameters of BJTs.	(5)
	b)	Explain Base width modulation.	(5)
	c)	With the help of necessary band diagrams, explain equilibrium, accumulation, depletion and inversion stages of a MOS capacitor.	(10)
9	a)	Derive the expression for terminal currents of a transistor. List the assumptions made for the derivation.	(10)
	b)	Explain the principle of operation of FinFET	(5)
	c)	Explain sub threshold characteristics of MOSFET	(5)

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