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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, JANUARY 2017

Course Code: **EC203**

Course Name: **SOLID STATE DEVICES (AE, EC)**

Max. Marks: 100 Duration: 3 Hours

PART A

Question No. 1 is compulsory. Answer question No. 2 or 3

1. (a) Derive the expression $n_0p_0 = n_i^2$ from fundamentals. (5)

   (b) A germanium sample is doped with 10^{16} boron atoms per cm^3. Find the electron concentration. Intrinsic carrier concentration of germanium is $2.5 \times 10^{13}/cm^3$ at 300K. (5)

   (c) An n- type silicon sample with $N_d = 10^{15}$ $/cm^3$ is steadily illuminated such that $g_{op} = 10^{20}$ EHP/cm^3-sec. If $\tau_n = \tau_p = 1\mu sec$ for this excitation. Draw the energy band diagram with the quasi Fermi levels at 300K. Intrinsic carrier concentration of silicon is 1.5×10^{10} $/cm^3$ (5)

2. (a) Explain the temperature dependence of carrier concentration of an extrinsic semiconductor with the help of graph. (5)

   (b) What is Hall Effect? Derive the expression for finding the carrier concentration of a semiconductor from Hall voltage. (10)

OR

3. (a) What is Einstein Relation? Derive the expression. (5)

   (b) Derive Continuity equation. Find the expression for the distribution of carriers in a semi-infinite semiconductor bar if steady injection of carriers occurs at one end. (10)

PART B

Question No. 4 is compulsory. Answer question No. 5 or 6

4. (a) Draw the charge density and electric field distribution within the transition region of a PN Junction with $N_d < N_a$. Label all the details. (5)

   (b) An abrupt silicon PN junction has $N_d = 10^{15}$ $/cm^3$ and $N_a = 10^{17}$ $/cm^3$. Draw the energy band diagram of the junction at equilibrium at 300K and find its contact potential

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from the diagram. Energy gap of silicon is 1.11eV and intrinsic carrier concentration is $1.5 \times 10^{10}/cm^3$. (5)

(d) Explain the working of Tunnel diode. Draw its characteristics curve. (5)

5. (a) Derive Ideal diode equation. (10)

(b) Draw the electron and hole component of current in a forward biased PN junction. Given that $N_d<N_a$ (5)

OR

6. (a) Explain the break down mechanisms occurred in abrupt PN junctions. (10)

(b) What is the depletion capacitance of a PN junction? Explain its variation with reverse bias voltage. (5)

PART C

Question No. 7 is compulsory. Answer question No. 8 or 9

7. (a) Derive the expression for terminal currents of a transistor. (10)

(b) Draw the energy band diagram of a MOS capacitor in accumulation and in inversion condition. (5)

(c) Explain the CV characteristics of a MOS capacitor (5)

8. (a) What are the mechanisms which cause base current in a transistor? (5)

(b) Draw the minority carrier distribution in PNP transistor during active mode. (5)

(c) Explain the amplification action of a transistor. (5)

(d) What is base width modulation? (5)

OR

9. (a) Explain the output characteristics of a MOSFET. (5)

(b) Derive the expression for drain current of MOSFET. (10)

(c) A silicon n channel MOSFET has $\mu_n=600cm^2/V\text{-}sec$, $C_{ox}=1.2 \times 10^{-7}\ F/cm^2$, $W=50\mu m$, $L=10\mu m$ and $V_{TH}=0.8V$. Find the drain current when

(i). $V_{GS}=2V$ and $V_{DS}=1V$

(ii) $V_{GS}=3V$ and $V_{DS}=5V$ (5)

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