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GOVERNMENT COLLEGE OF ENGINEERING, KANNUR.

Department of Electronics and Communication Engineering

Third Semester First Series Examination November- 2022 (2019 Scheme)

Course code: ECT201 - ECE - B

Course Name: SOLID STATE DEVICES

Max. Marks: 50   Duration: 90 Minutes

PART A

Answer all questions. Each question Carries 3 marks

1. What is effective mass? Explain? (3 Marks)
2. What is the significance of Fermi Dirac Statistics? (3 Marks)
3. How will you classify semiconductors? (3 Marks)
4. What is mobility and drift velocity? Derive an expression for mobility. (3 Marks)
5. What are excess carriers and Quasi Fermi levels? (3 Marks)

PART B

6. (a) Explain Fermi Dirac statistics with the help of probability vs energy diagram for different temperatures and show the energy band diagrams of intrinsic and extrinsic semiconductors. Explain the position of Fermi energy levels in such materials.
(b) A Si sample is doped with $2X10^{17}$phosphorous atoms/cm^3. Calculate the electron and hole concentrations in the material at 300K. Also calculate the relative position of Fermi level with respect to intrinsic energy level (Ei). (8+6 Marks)

OR

7. (a) Explain the temperature dependence of intrinsic carrier concentration with the help of equation and graph.
(b) What is the behaviour of free carriers in an extrinsic material under different values of temperature and explain each region in the graph.
(c) A Si sample is doped with $3X10^{17}$phosphorous atoms/cm^3 and $2X10^{17}$boron atoms/cm^3. Calculate the electron and hole concentrations in the material at 300K. Also calculate the relative position of Fermi level with respect to intrinsic energy level (Ei).

(5+4+5 Marks)

8. A 0.5um thick sample of GaAs (Band gap=1.6eV) is illuminated with mono chromatic light of hv=2.0eV. The absorption coefficient α is $1X10^{-4}$/cm. The power incident on the

sample is 2mW. (i) Find the total energy absorbed by the sample per second. (ii) Find the rate of excess thermal energy given up by electrons to the lattice before recombination. (iii) Find the number of photons/s given off from recombination events, assuming perfect quantum efficiency.

(b) Explain direct recombination and indirect recombination with the help of diagrams.

What is a recombination center and trapping center? (8+6 Marks)

OR

9. (a) What is diffusion? Derive an expression for diffusion current density.
   (b) $2X10^{14}$EHP/cm^3 are created optically every microsecond in a Si sample with $n0 = 10^{15}cm^{-3}$and τ_n=2μs. Calculate the equilibrium electron and hole concentrations and Fermi level at 300K (ni=$1.5X10^{10}/cm^3$). What is the excess carrier concentration created in the material and show the positions of quasi Fermi levels. What is the change in conductivity of the material with the creation of excess carriers (μ_n=1500cm^2/Vs ,μ_p=500cm^2/Vs).
   (6+8 Marks)

10. Explain the total current density of electrons and holes in the presence of electric field and concentration gradient. Show the directions of electric field, concentration gradient, carrier flow and current densities. (7 Marks)

OR

11. *A sample of Si is doped with* 10^{17} phosphorous atoms/cm^3. Calculate its resistivity if *μ_n=1500cm^2/Vs.* Find the hall voltage if thickness=100um, I=1mA, Bz=10^{-5}Wb/cm^2
    (7 Marks)