Hall Ticket Number:

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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

B.E. (CBCS) I-Semester Supplementary Examinations, June/July-2019

Semiconductor Physics

(CSE & IT)

Time: **3** hours Max. Marks: **60**

*Note: Answer **ALL** questions in **Part-A** and any **FIVE** from **Part-B***

Part-A (10 × 2 = 20 Marks)

1. Narrate the procedure to find Miller index of a crystal plane with an example
2. Assuming first order diffraction at $2\theta = 45^0$ from (110) lattice planes, calculate the lattice constant of BCC iron when x-rays of wavelength 0.2nm incident on it.
3. Calculate lowest energy level for a neutron in a nucleus by treating it as if it is in an infinite potential well of width equal to 10^{-14} m. Compare this with the lowest energy level for an electron in the same infinite potential well.
4. Write a note on direct and indirect band gap semiconductors with examples.
5. Distinguish between the fermi levels of a metal and various types of semiconductors with appropriate diagrams.
6. Find the resistance of an intrinsic germanium rod of dimensions 2cmx1mmx1mm at 300K, if mobilities of electron and holes respectively are 0.40 m^2/V-s and 0.2 m^2/V-s and electron concentration is $2.5x10^{19}/m^3$
7. The hole concentration of a semiconductor is given by $p(x)= 10^{15}\ e^{(-x/Lp)}\ cm^3$ (x>0). The hole diffusion coefficient is $12cm^2/s$. the value of diffusion current at x=0 is 6.4 A/cm^2. Find the value of L_p.
8. Distinguish between diffusion and drift.
9. Define induced absorption and spontaneous emission. Give at least one practical applications of each process.
10. What are excitons? Explain briefly.

Part-B (5 × 8 = 40 Marks)

11. a) Describe and illustrate the following crystal defects in a lattice (i) Schottky defect and (ii) Frenkel Defect. Obtain expression for Schottky defects in an ionic crystal at 300K. [5]

    b) What is effect of temperature on point defects in a crystal? The fraction of vacancy sites in a metal at 400^0C is $1x10^{-9}$. Estimate the vacancy sites fraction at 950^0C. [3]

12. a) List the assumptions of Fermi-Dirac statistics. Derive expression for distribution of electrons in various energy states according to F-D statistics at a given temperature. [6]

    b) Show that the effective mass of an electron in a crystal lattice is inversely proportional to curvature of E-k curve of a band. [2]

13. a) State Hall effect. Derive expression for Hall voltage and Hall coefficient. [6]

    b) Calculate intrinsic carrier concentration of silicon at room temperature and 450K from the following data: $N_c= 2.8x10^{19}/cm^3$, $N_v = 1.04x10^{19}/cm^3$ and E_g =1.1 eV. Suppose E_g remains constant during this temperature range. What is increase in carrier concentration when temperature is changed? [2]

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14. a) Obtain expression for total current due to diffusion and drift of electrons and holes in a semiconductor. [6]

    b) In a p-type GaAS samples electrons are added from one side. If the mobility of the charge carrier is 3900 $cm^2/V\text{-}s$ at 300 K, evaluate diffusion coefficient and diffusion length, if recombination time is 1.6 ns. [2]

15. a) Describe stimulated emission process and obtain expression for gain and gain coefficient in illuminated semiconductor of incident energy density Uv. [6]

    b) Narrate Fermi- Golden rule for optical transitions [2]

16. a) Define density of states. Derive expression for density of states of bulk semiconductor [6]

    b) Discuss the diamond crystal structure with a neat sketch. [2]

17. Answer any ***two*** of the following:

    a) Write a note on conductivity of intrinsic and extrinsic semiconductors. On what factors conductivity of a semiconductor depends? [4]

    b) Briefly explain metal- semiconductor junctions with appropriate energy band diagrams. [4]

    c) Explain transition probabilities in a semiconductor using Shockley-Read-Hal mechanisms. [4]