23PHY110 Physics of Semiconductors

Duration: Three hours

Maximum: 100 Marks

Course Outcomes (COs):

CO	Course Outcomes
CO01	Understand the crystal structure of semiconductors
CO02	Understand semiconductors based on energy band gap
CO03	Understand current flow in semiconductors
CO04	Understand the behaviour of pn junctions & MOSFETs

Answer all the questions (Each question carries 4 Marks)

1) With the help of a neat diagram, distinguish between direct and indirect band gap semiconductors? Give examples?
[4 Marks] [CO02] [BTL 2]

2) What are the assumptions of the Drude-Lorentz theory of metals?
[4 Marks] [CO02] [BTL 1]

3) Find the interplanar spacing of (2 2 2) planes of copper, which has an FCC structure, given the atomic radius as 0.128 nm?
[4 Marks] [CO01] [BTL 3]

4) Explain Schottky and Frenkel defects with examples?
[4 Marks] [CO01] [BTL 1]

5) Determine the Miller indices of a plane in a tetragonal crystal with intercepts of 2 Å, 2.5 Å, and 3 Å on the axes, given the lattice constant ratio a:c = 1:2?
[4 Marks] [CO01] [BTL 3]

6) List the seven types of crystal systems along with their parameters in a table, and provide examples?
[4 Marks] [CO01] [BTL 1]

7) Distinguish between intrinsic and extrinsic semiconductors? What happens when an intrinsic semiconductor is doped with trivalent impurity?
[4 Marks] [CO03] [BTL 2]

8) Explain the carrier concentration in intrinsic semiconductors?
[4 Marks] [CO03] [BTL 1]

9) Define the Hall effect and give the expression for Hall voltage, defining all the variables?
[4 Marks] [CO03] [BTL 1]

10) Explain the three operating regions of a MOSFET with reference to the current-voltage characteristics?
[4 Marks] [CO04] [BTL 2]

Answer all the questions (Each question carries 10 Marks)

11) What are the assumptions of the classical free electron theory? Derive the expression for the electrical conductivity of a material based on the classical free electron theory?

[10 Marks] [CO03] [BTL 3]

12) Define point defects in crystalline solids. Explain the different types of defects, including line defects, surface defects, and volume defects? [10 Marks] [CO01] [BTL 1]

13) Illustrate the formation of a P-N junction with a clear diagram. Explain the biasing conditions for a P-N junction? [10 Marks] [CO04] [BTL 2]

14) Define the Fermi-Dirac distribution function. Explain how the Fermi-Dirac distribution function varies with temperature? [10 Marks] [CO02] [BTL 2]

15) What is a Field Effect Transistor (FET)? Explain the structure and working principle of a Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET). Also, distinguish between depletion mode and enhancement mode MOSFETs? [10 Marks] [CO04] [BTL 2]

16) (a) What are extrinsic semiconductors? Explain the difference between n-type and p-type semiconductors? [6 Marks] [CO02] [BTL 2]

(b) Discuss the energy level diagrams of n-type and p-type semiconductors?

[4 Marks] [CO02] [BTL 2]

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Course Outcome /Bloom's Taxonomy Level (BTL) Mark Distribution Table

CO	Marks	BTL	Marks
CO01	26	BTL 1	30
CO02	28	BTL 2	52
CO03	22	BTL 3	18
CO04	24	BTL 4	
CO05		BTL 5	
CO06		BTL 6	