



**2021/TDC/CBCS/ODD/  
PHSHCC-502T/156**

**TDC (CBCS) Odd Semester Exam., 2021  
held in March, 2022**

**PHYSICS**

**( 5th Semester )**

**Course No. : PSHCC-502T**

**( Solid-State Physics )**

Full Marks : 50

Pass Marks : 20

**Time : 3 hours**

*The figures in the margin indicate full marks  
for the questions*

**SECTION—A**

**Answer any ten of the following questions :  $2 \times 10 = 20$**

1. Distinguish between crystalline and amorphous solids.

2. Show that in simple cubic lattice

$$d_{100} : d_{110} : d_{111} = 1 : 0.71 : 0.58$$



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3. Define primitive cell and unit cell.
4. What do you mean by lattice vibration?
5. Define forbidden band in lattice vibration.
6. Discuss the limitations of Einstein's theory of lattice specific heat.
7. What is a magnetic material? What are its different classes?
8. Explain the difference among ferro-, antiferro- and ferrimagnetic materials.
9. What is hysteresis? State the significance of hysteresis loop.
10. What do you mean by dielectric polarization?
11. State the relation between electronic polarizability and relative permittivity.
12. Compare ferroelectricity with piezoelectricity.
13. What is Hall effect? Why is the Hall coefficient positive in some metals?

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14. Discuss the effect of magnetic field on superconductivity.
15. State the variation of position of Fermi level in extrinsic semiconductor with temperature.

#### SECTION—B

Answer any *five* of the following questions : 6×5=30

16. (a) Show that in a cubic crystal of side  $a$ , the inter-planar spacing between consecutive parallel planes of Miller indices  $(hkl)$  is

$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}} \quad 3$$

- (b) Draw the following planes in the case of an FCC structure : 3

(i) (100)

(ii) (110)

(iii) (112)

17. (a) What are Miller indices? Obtain the Miller indices of a plane having intercepts of  $a$ ,  $b/2$  and  $\infty$  on the  $a$ -,  $b$ - and  $c$ -axis respectively. 1+2=3

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( Turn Over )





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- (b) State Bragg's law of X-ray diffraction. The spacing between successive (100)-planes of NaCl is  $2.82 \text{ \AA}$ . X-rays incident on the surface of the crystal is found to give rise to first-order Bragg reflection at glancing angle  $8.8^\circ$ . Calculate the wavelength of X-rays.  $1+2=3$
18. (a) What is a phonon? Name the different branches of the dispersion relation curve in case of diatomic lattice. What is the difference between the two branches?  $3$
- (b) Explain the origin of acoustical and optical branches in linear diatomic lattice. Why are these branches named so?  $3$
19. (a) Give a comparative study of Einstein's theory and Debye theory of specific heat of solids.  $3$
- (b) What is Debye temperature? Write down the Einstein's and Debye's expressions for the specific heat of solids.  $3$
20. (a) State Curie-Weiss law and discuss its application to ferromagnetic materials.  $3$
- (b) Point out the essential difference between the classical theory and quantum theory of paramagnetism.  $3$

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21. (a) If the magnetization and flux density of a magnetic material be  $3200 \text{ A/m}$  and  $0.005 \text{ Wb/m}^2$ , then calculate the relative permeability of the material.  $3$
- (b) Explain the B-H loop with the help of domain theory.  $3$
22. (a) What is local field? Starting from Clausius-Mosotti equation, explain the origin of spontaneous polarization.  $1+2=3$
- (b) What are the various components of the local electric field at an atom in a crystal? Obtain the Lorentz relation for the local electric field.  $1+2=3$
23. (a) Discuss the origin of ferroelectricity. What is polarization catastrophe?  $2+1=3$
- (b) Write a short note on any one of the following :  $3$
- (i) Relaxation time of polarization
  - (ii) Internal field of solids
  - (iii) Debye equation

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( 6 )

24. (a) The solution of Schrödinger equation for one-dimensional periodic lattice is given by

$$P \frac{\sin \alpha a}{\alpha a} + \cos \alpha a = \cos ka$$

when  $\alpha^2 = \left( \frac{2mE}{\hbar^2} \right)$ . The symbols have

their usual significance. Discuss the formation of energy bands in a solid. 3

- (b) What is Hall angle? Find an expression for Hall voltage and Hall coefficient. State the importance of this effect. 3

25. (a) Write down first and second London equations. What do you mean by London penetration depth? 3

- (b) What is Meissner effect? Show that a superconductor behaves as a diamagnet. 3

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