

(6 pages)

Reg. No. : .....

Code No. : 6384

Sub. Code : HPHM 32

M.Sc. (CBCS) DEGREE EXAMINATION,  
NOVEMBER 2014.

Third Semester

Physics

SOLID STATE PHYSICS

(For those who joined in July 2012 onwards)

Time : Three hours

Maximum : 75 marks

SECTION A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The Bloch theorem can be expressed as

- (a)  $\psi_k(r) = u_k(r)e^{-i\vec{k} \cdot \vec{r}}$  (b)  $\psi_k(r) = \frac{e^{-i\vec{k} \cdot \vec{r}}}{u_k(r)}$   
(c)  $\psi_k(r) = e^{-i\vec{k} \cdot \vec{r}} u_{kr}$  (d)  $\psi_k(r) = u_k(r)e^{i\vec{k} \cdot \vec{r}}$

2. In case of monoatomic one dimensional lattice, the range of k values for first Brillouin zone is

- (a)  $0 \leq P \leq \frac{\pi}{a}$  (b)  $0 \leq P < \frac{2\pi}{a}$   
(c)  $\frac{-\pi}{a} \leq k \leq \frac{\pi}{a}$  (d)  $\frac{-\pi}{2a} \leq k \leq \frac{\pi}{-2a}$

3. The dispersion relation for a one dimensional mono atomic lattice (k-propagation vector and c-force constant)

- (a)  $w = \sqrt{\frac{4x}{m}} \sin \frac{ka}{2}$  (b)  $w = \sqrt{\frac{2c}{m}} \sin \frac{ka}{2}$   
(c)  $w = \sqrt{\frac{4c}{m}} \sin ka$  (d)  $w = \sqrt{\frac{2c}{m}} \sin ka$

4. The following expression in the condition for diffraction

- (a)  $\vec{K} \cdot \vec{G} = G^2$  (b)  $\vec{K} \cdot \vec{G} = 2G^2$   
(c)  $2\vec{K} \cdot \vec{G} = G^2$  (d)  $2\vec{K} \cdot \vec{G} + G^2 = 0$

5. The Central equation  $(\lambda_k - E) C(k) + \sum U_G C(k - G) = 0$  in which  $\lambda_k$  is equal to

- (a)  $\frac{\hbar^2}{k^2}$  (b)  $\frac{\hbar^2 k^2}{2m}$   
(c)  $\frac{\hbar^2}{2m}$  (d)  $\frac{\hbar^2 k^2}{8m}$

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6. In the \_\_\_\_\_ zone scheme, the energy  $E_k$  of a band is a periodic function in the reciprocal lattice.

- (a) Periodic
- (b) Extended
- (c) Reduced
- (d) Periodically reduced

7. The electrical resistivity " $\rho$ " is given by

- (a)  $\rho = \frac{ne^2\tau}{m}$
- (b)  $\rho = \frac{ne^2}{\tau m}$
- (c)  $\rho = \frac{m}{ne^2\tau}$
- (d)  $\frac{me^2}{n\tau} = \rho$

8. The density of states is given by

- (a)  $D(\epsilon) = \frac{3N}{\epsilon}$
- (b)  $D(\epsilon) = \frac{3N}{5\epsilon}$
- (c)  $D(\epsilon) = \frac{3N}{2\epsilon}$
- (d)  $D(\epsilon) = \frac{3N}{8\epsilon}$

9. At all temperatures  $f(\epsilon)$  is equal to  $\frac{1}{2}$  when

- (a)  $\epsilon = \mu$
- (b)  $\epsilon = 2\mu$
- (c)  $\epsilon = \sqrt{\mu}$
- (d)  $\epsilon = \mu^2$

10. The number of orbitals with the same energy is called the \_\_\_\_\_.

- (a) Fermi Energy
- (b) Degeneracy level
- (c) Pauli exclusion principle
- (d) Fermi-dirac distribution

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 250 words.

11. (a) Explain Bragg diffraction conditions.

Or

(b) Derive Bloch equations.

12. (a) Explain the Quantization of elastic waves.

Or

(b) Describe the density of states in one and three dimensions.

13. (a) Describe DeHass-Van Alphen effect. Also describe its special case low temperature and high magnetic field.

Or

(b) Using Fermi sphere, find electrical conductivity and ohm's law.



14. (a) Calculate the magnetic moment ( $\mu$ ) using Langevin dia magnetic equation.

Or

- (b) Compare Ferrimagnetic order and Antiferri magnetic order.
15. (a) What are colour centers? Explain F and M centres in alkali halides.

Or

- (b) Explain magnetoresistance in a two-dimension channel.

SECTION C — ( $5 \times 8 = 40$  marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 600 words.

16. (a) Show that the set of reciprocal lattice vector determines the possible x-ray reflections. Find the expression for the structure of a crystal. Evaluate the structure factor for bcc and fcc lattices.

Or

- (b) Explain Lave scattered wave amplitude using Fourier analysis.

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17. (a) Discuss in detail the vibrations of a lattice with two atoms per primitive cell.

Or

- (b) Derive the expression for Debye model of the Specific heat and discuss limitations.
18. (a) Derive the Fermi energy equation and density of states for free electron gas in three dimension.

Or

- (b) Discuss in detail, the heat capacity of the electron gas with diagram.
19. (a) Using Quantum theory of paramagnetism, derive the effective number of Bohr magnetons.

Or

- (b) Explain in detail Magnons.
20. (a) Explain dislocations and burger vector.

Or

- (b) Explain p-n Junctions in single crystals and also give the rectification of it.

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