

2017

PHYSICS

(Major)

Paper : 6.2

Full Marks : 60

Time : 3 hours

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

(Mathematical Methods)

(Marks : 15)

1. Answer any *two* from the following : $1 \times 2 = 2$

(a) What is the value of Kronecker delta δ_{21}^{12} ?

(b) In an N -dimensional space, how many different expressions are represented by $A_m^{pq} B_{pk}^r C_{sr}^{kt}$?

(c) Name the coordinate system where contravariant, covariant and mixed tensors are identical.

(2)

2. Answer any four from the following : $2 \times 4 = 8$

- (a) If $A_{\lambda\mu}$ is a skew-symmetric tensor, show that $(B_\nu^\mu B_\tau^\sigma + B_\tau^\mu B_\nu^\sigma) A_{\mu\sigma} = 0$.
- (b) If A^{mn} is an anti-symmetric tensor and B_m is a vector, show that $A^{mn} B_m B_n = 0$.
- (c) Show that $\frac{\partial A_\lambda}{\partial x_\mu}$ is not a tensor although A_λ is a covariant tensor of rank 1.
- (d) If A_k^{ij} and B_q^p are tensors, show that $A_k^{ij} B_q^i$ is not a tensor.
- (e) Determine whether acceleration is a contravariant or covariant tensor, mention its rank.

3. Answer any one from the following : 5

- (a) A covariant tensor has components xy , $2y - z^2$, xz in rectangular coordinates, find its covariant components in spherical coordinates.
- (b) If $\vec{A}$ and $\vec{B}$ are two vectors, then determine whether the components of $\vec{A} \cdot \vec{B}$ and $\vec{A} \times \vec{B}$ form a tensor. If so, find their ranks.
- (c) Express Lorentz force law in tensor form. Find its rank.

(3)

(Solid State Physics)

(Marks : 45)

4. Choose the correct answer from the following : $1 \times 7 = 7$

- (a) The packing factor of bcc structure is
 - (i) 52%
 - (ii) 34%
 - (iii) 68%
 - (iv) 74%
- (b) The Miller indices of the plane parallel to the x and y axes are
 - (i) (100)
 - (ii) (001)
 - (iii) (010)
 - (iv) (111)
- (c) Ionic solids have
 - (i) high melting point and high boiling point
 - (ii) high melting point and low boiling point
 - (iii) low melting point and low boiling point
 - (iv) low melting point and high boiling point

- (d) The bond between argon atoms is
- (i) covalent
 - (ii) van der Waals
 - (iii) ionic
 - (iv) metallic
- (e) Magnetic susceptibility χ is
- (i) dipole moment per unit volume
 - (ii) torque per unit area
 - (iii) magnetisation per unit field intensity
 - (iv) None of the above
- (f) In an n -type semiconductor, the position of the Fermi level at 0 K
- (i) lies below the donor level
 - (ii) lies halfway between the conduction band and donor level
 - (iii) coincides with intrinsic Fermi level
 - (iv) can be anywhere depending on doping concentration
- (g) Superconducting state is perfectly
- (i) paramagnetic
 - (ii) diamagnetic
 - (iii) ferromagnetic
 - (iv) ferrimagnetic

5. Give very short answers of the following questions : 2×4=8
- (a) Distinguish between crystalline solid and amorphous solid.
 - (b) Draw (112) plane of an fcc structure.
 - (c) State Wiedemann-Frantz law.
 - (d) State Bloch theorem.
6. Give short answers of the following questions (any two) : 5×2=10
- (a) Deduce Bragg's law in X-ray diffraction. The first-order reflections of a beam of X-rays of wavelength $1.54 \text{ \AA}$ from the (100) face of a crystal of the simple cubic type occurs at an angle of 11.29° . Calculate the length of the unit cell ($\sin 11.29^\circ = 0.1957$). 3+2=5
 - (b) State the assumptions of free-electron theory of metal. 5
 - (c) Explain Meissner effect. What do you mean by type I and type II superconductors? 2+3=5
 - (d) Write down the quantum mechanical expression for Lorentz number. For copper at 20°C , the electrical and thermal conductivities are $1.72 \times 10^8 \Omega\text{m}$ and $386 \text{ Wm}^{-1}\text{K}^{-1}$ respectively. Calculate Lorentz number. 2+3=5

7. Answer the following questions :

- (a) What do you mean by cohesive energy? Draw a unit cell of NaCl. Show that the Madelung constant for a one-dimensional array of ions of alternating sign with a distance between two successive ions is equal to $2 \log 2$.

$$2+2+6=10$$

Or

- (b) Write down the distinguishing properties of paramagnetic, diamagnetic and ferromagnetic materials. Give example of each type. 10
- (c) Write short notes on (any one) : 10
- Different types of crystal bonding and extrinsic semiconductors
 - Intrinsic and extrinsic semiconductors
 - Crystal structure determination by powder method
 - Larmor precession
