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 : 1×2=2

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

(b) In an *N*-dimensional space, how many different expressions are represented by $A^{pq}_{m} B^{r}_{pk} C^{kt}_{sr}$?

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

2. Answer any *four* from the following : 2×4=8

(a) If $A_{\lambda\mu}$ is a skew-symmetric tensor, show that $(B^{\mu}_{\nu}B^{\sigma}_{\tau} + B^{\mu}_{\tau}B^{\sigma}_{\nu})A_{\mu\sigma} = 0$.

(b) If A^{mn} is an anti-symmetric tensor and B_m is a vector, show that $A^{mn}B_mB_n = 0$.

(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^{ij}_{k} and B^{p}_{q} are tensors, show that $A^{ij}_{k}B^{i}_{q}$ 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.

(Solid State Physics)

(*Marks* : 45)

4. Choose the correct answer from the following : 1×7=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 Å 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° = 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 super-conductors? 2+3=5

(d) Write down the quantum mechanical expression for Lorentz number. For copper at 20 °C, the electrical and thermal conductivities are $1{\cdot}72\times10^{8}$ Ωm and 386 $Wm^{-1}K^{-1}$ 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 Medelung 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

(i) Different types of crystal bonding

(ii) Intrinsic and extrinsic semiconductors

(iii) Crystal structure determination by powder method

(iv) Larmor precession

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