**Bachelor of Science (B.Sc.) Semester—IV (C.B.S.) Examination**
**PHYSICS**
**Paper—I**
**(Solid State Physics, X-Ray and Laser)**

Time : Three Hours] [Maximum Marks : 50

**N.B. :—** (1) **ALL** questions are compulsory.
(2) Draw neat diagrams wherever necessary.

**EITHER**

1. (A) What are the symmetry operations in crystals ? Explain non-existence of five fold symmetry. 5

(B) (i) What are Miller indices ? Explain the procedure to find Miller indices of a crystal plane. 3

(ii) Draw (1 0 0), (1 1 0), (1 1 1) and (2 2 2) planes. 2

**OR**

(C) Show that the interplanar distance for a simple cubic structure is given by $d_{hk\ell} = \frac{a}{\sqrt{h^2 + k^2 + \ell^2}}$ where the letters have their usual meaning. 2½

(D) What is packing fraction ? Obtain its value for body centred cubic structure. 2½

(E) Explain the crystal structure of NaCl. 2½

(F) Rhodium, having bcc structure, has atomic radius of 0.1345 nm. Determine the lattice constant. 2½

**EITHER**

2. (A) Explain the construction and working of Bragg's spectrometer. Explain its use for the determination of wavelength of X-rays. 5

(B) (i) Obtain Bragg's condition for X-ray diffraction. 3

(ii) X-rays of wavelength 0.5Å are diffracted at an angle of 5° in first order. Calculate the interplanar spacing of the crystal. 2

**OR**

(C) Explain the construction of reciprocal lattice. 2½

(D) Obtain the Bragg's diffraction condition for reciprocal lattice. 2½

(E) Define reciprocal lattice vectors and obtain the relation between translation vector in direct and reciprocal lattice. 2½

(F) The primitive vector of direct lattice are given by : $\vec{a} = 2\vec{i}$, $\vec{b} = \vec{i} + 2\vec{j}$ and $\vec{c} = \vec{k}$. Find the primitive vectors in reciprocal lattice. 2½

**EITHER**

3. (A) Explain the construction and working of a Coolidge tube with a well-labelled diagram. 5

(B) (i) Explain characteristic X-ray spectra and draw the energy level diagram. 3

(ii) Calculate the wavelength of $K_\alpha$ line emitted from Copper (Given : $R = 1.1 \times 10^7\ m^{-1}$, $Z = 29$) 2

**OR**

(C) What are X-rays ? State their properties. 2½

(D) Explain Moseley's law for X-rays. State its significance. 2½

(E) Show that absorption of X-rays by a material follows exponential law. 2½

(F) Calculate the maximum frequency of X-rays when a p.d. of 25 kV is applied. 2½

**EITHER**

4. (A) Explain the principle, construction and working of He-Ne laser. State the drawbacks of He-Ne laser. 5

(B) (i) Obtain the relation between Einstein's coefficient A and B. 3

(ii) Coherence length of Sodium $D_2$-Line is 2.5 cm and wavelength is 5890 Å. Calculate the coherence time and spectral width of Line. 2

**OR**

(C) Explain the lasing action in three level Laser System. 2½

(D) Name the different pumping schemes in Laser and explain any two of them. 2½

(E) What are the applications of Laser ? 2½

(F) Calculate the energy of a photon of Laser beam of wavelength 6328 Å. 2½

5. Attempt any **TEN** questions :—

(i) State two differences between amorphous and crystalline solids.

(ii) What is the number of atoms per unit cell of BCC and FCC crystal ?

(iii) Find the Miller indices of a plane whose intercepts are 2a, 3b and 4c on crystallographic axes.

(iv) What is Bremsstrahlung in X-rays ?

(v) What is Duane-Hunt Law ?

(vi) What is Auger effect ?

(vii) Write the Laue's equation for the diffraction of X-rays.

(viii) Write any two properties of reciprocal lattice.

(ix) What are the different standard methods for X-ray diffraction ?

(x) What is Population Inversion ?

(xi) State the salient features of a Laser beam.

(xii) What is the coherence length of a Laser beam having coherence time of $3.33 \times 10^{-15}$ sec ? 1×10=10