UG (CBCS) EVEN SEMESTER EXAMINATION, 2024

EDUCATION
(B.Sc. B.Ed.)

6th Semester

Course No. : BSPP – 603

(Quantum mechanics, Atomic & Nuclear Physics, Crystallography & Electronics)

Full Marks : 50
Pass Marks : 20

Time : 2 hours

The figures in the margin indicate full marks for the questions

1. (a) What is Compton effect? 1

   (b) Show that the Compton shift in wavelength is given by $\Delta\lambda = \frac{h}{m_e c}(1 - \cos\theta)$. Also estimate $\Delta\lambda$ at $\theta = 0, 90^0, 180^0$ 9

Or

2. (a) State Heisenberg's uncertaintity principle. Derive the binding energy of an electron of an atom of atomic number Z using Heisenberg's uncertaintity principle. Also find the binding energy of electron of H and He atoms. 8

   (b) Calculate the de Broglie wavelength of an electron accelerated through a potential of 150 V. 2

3. (a) Describe the construction and working of a Bainbridge's mass spectrograph with a neat labelled diagram. 8

   (b) Write the two uses of mass spectrograph. 2

Or

4. (a) Show that the radius and total energy of electron in n^{th} permissible orbit for hydrogen atom are

   $r_n = \frac{n^2h^2\varepsilon_0}{\pi e^2 m}$ and $E_n = \frac{me^4}{8\varepsilon_0{}^2 n^2 h^2}$ 6

   (b) Discuss the effect of nuclear motion on E_n. 4

5. Consider a radioactive series A→B→C →.... X(stable). If λ_1 and λ_2 are decay constants of A and B, show that $N_2 = \frac{\lambda_1 N_0}{\lambda_2 - \lambda_1}\left[e^{-\lambda_1 t} - e^{-\lambda_2 t}\right]$. Discuss the secular and transient equilibrium. 6+4=10

Or

6. (a) Describe the construction and working of a linear accelerator with a labelled diagram. For successive accelerations in successive gaps show that the tubes 1, 2, 3, etc., must have lengths proportional to 1, √2, √3, etc. 8

   (b) Write two limitations of the linear accelerator. 2

7. (a) For a cubic crystal (fcc), show that the lattice constant is $a = \left(\frac{4M}{\rho N_A}\right)^{1/3}$ 4

   The symbols indicate the usual meanings.

   (b) Show that for a crystal cubic symmetry the direction [*h, k, l*] is perpendicular to the plane. 6

Or

8. (a) Derive the interplanar spacing d(h k l) between two parallel planes with Miller indices (h k l) and show that for a simple cubic lattice is 6

   $$d(h\ k\ l) = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

   (b) Find the Miller indices for planes which intercepts $\vec{a}, \vec{b}$ and $\vec{c}$ at (i) 3a, 3b, 3c (ii) 3a, 2b, 2c (iii) a, b/2, c (iv) a, 2b, ∞ 4

9. (a) Describe the working of a half-wave rectifier using pn junction diode. 5

   (b) Show that in half-wave rectification, a maximum of 40.6% of ac power is converted into dc power. 5

Or

10. (a) Show that the maximum efficiency of a full-wave rectifier is 81.2%. 7

    (b) A full-wave rectifer uses two diodes, the internal resistance of each diode may be assumed constant at 20Ω. The transformer r.m.s secondary voltage from centre tap to each end of secondary coil is 50 V and load resistance is 980Ω. Find (i) the mean load current (ii) the r.m.s value of load current. 3

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