



RAN - 2103000205021001

RAN-2103000205021001**T. Y. B. Sc. (Sem. - V) Examination March - 2023****Physics : Paper - VI****Classical Mechanics and Solid State Physics****[Total Marks: 50****सूचना : / Instructions**

(1)

नीचे दृशविले निशानीवाणी विगतो उत्तरवही पर अवश्य लखवी.
Fill up strictly the details of signs on your answer book

Name of the Examination:

T. Y. B. Sc. (Sem. - V)

Name of the Subject :

Physics : Paper - VI Classical Mechanics and Solid State Physics

Subject Code No.: 2103000205021001

Seat No.:

Student's Signature

- (2) Draw neat diagrams wherever necessary.
- (3) Symbols used in the paper have their usual meaning.
- (4) Figures to the right indicate mil marks of the question.
- (5) Scientific calculator may be used.

Q. 1. Answer the following questions in brief:**(10)**

- (i) A planet moves around the sun. At a given point P, it is closest from the sun at a distance d_1 and has a speed v_1 . Find its speed at another point Q, when it is farthest from the sun at a distance d_2 .
- (ii) What is the degree of freedom for system having 3 particle and 2 independent constrains?
- (iii) Give two example of central force?
- (iv) If a generalized co-ordinate of dimension of electric potential, then what is the unit of Generalized velocities?
- (v) Define Holonomic Constraints.
- (vi) What do you understand by free electron gas?
- (vii) Mention any one application of hall effect.

- (viii) Write down the solution of Schrödinger equation according to Bloch.
- (ix) Mention the region in k-space for first Brillouin zone.
- (x) Resistivity of rod is $2 \times 10^{-8} \Omega\text{m}$ find its conductivity?

Q. 2. (a) Attempt any one of the following in details: (7)

- (i) What is central force? Using central force motion obtain conservation of angular momentum and prove the second law of Kepler's.
- (ii) How does two body problem to a one body problem? Compare the corresponding factor such as mass, distance and centre of mass in two cases.

Q. 2. (b) Attempt any one of the following: (3)

- (i) A Force $\vec{F} = a\hat{i} - 12\hat{j} - 16\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 8\hat{k}$ then find value of a for which angular momentum conserved.
- (ii) The maximum and minimum distances of a comet from the sun are 8×10^{12} m and 1.6×10^{12} m. If its velocity when nearest to the sun is 60 m/s, what will be comet velocity in m/s when it is farthest.

Q. 3. (a) Attempt any one of the following in details: (7)

- (i) Explain D'Alembert's principle. Derive Lagrange's equation of motion from D'Alembert's principle.
- (ii) Obtain the Lagrange equations of motion for a spherical pendulum, i.e., a point mass suspended by a rigid weightless rod.

Q. 3. (b) Attempt any one of the following: (3)

- (i) Consider a motion of particle in three dimension under the force F , Obtain the Langrangian equations and show that they are equivalent to Newton's equations.
- (ii) Is the Langrangian formulation more advantageous than the Newtonian formulation? Why ?

Q. 4. (a) Attempt any one of the following in details: (7)

- (i) Derive the Fermi energy and density of states for the free electron-gas model for metal in three dimension.
- (ii) By using Free electron gas model for metal derive equation of resistivity and conductivity equation for metal.

Q. 4. (b) Attempt any one of the following: (3)

- (i) The Hall coefficient of a specimen is $3.66 \times 10^{-4} \text{ m}^3/\text{s}$. It's resistivity is $7.67 \times 10^{-3} \text{ ohm-m}$. Find mobility and concentration of electrons.
- (ii) The resistivity of copper at room temperature is $1.7 \times 10^{-8} \text{ ohm-meter}$. If the density of mobile electrons is $8.4 \times 10^{28} \text{ m}^{-3}$, calculate the relaxation time for free electrons in copper.
(mass of electron $9.1 \times 10^{-31} \text{ kg}$, charge of electron $1.6 \times 10^{-19} \text{ C}$)

Q. 5. (a) Attempt any one of the following in details: (7)

- (i) Discuss Kronig penny model of movement of electron in a periodic field of crystal.
- (ii) Describe nearly free electron model. Using nearl free electron model schematically shows how the energy dispersion relation give rise to band gap.

Q. 5. (b) Attempt any one of the following: (3)

- (i) Electron linear momentum $0.32 \times 10^{-6} \text{ Ns}$ and mass of electron $9.1 \times 10^{-31} \text{ kg}$ then inside the conductor according to Kronig penny model when (barrier strength) $P \rightarrow 0$. Find the kinetic energy of free electron.
- (ii) Calculate the energy of state for quantum number $n = 1$. Lattice spacing 0.285 \AA , mass of electron $9.1 \times 10^{-31} \text{ kg}$, $h = 6.625 \times 10^{-34} \text{ Js}$.