2023

B.Sc. (Honours)

B.Sc. Fifth Semester End Examination - 2023

PHYSICS

PAPER - DSE-1T

Full Marks : 60 *Time : 3 hours*

The figures in the right-hand margin indicate marks.
Candidates are required to give their answers in their own words as far as practicable.
Illustrate the answers wherever necessary.

Group - A

1. Answer any 10 questions : 10×2=20

(a) If F and G are functions of positon co-ordinates q_i, and momentum co-ordinates p_i, define the poisson's brackets of F and G. Prove that [F,G]=–[G,F] 2

(b) Explain cyclic co-ordinates with example. 2

(c) Define stable and unstable equilibrium. 2

(d) State the postulates of special theory of relativity. 2

(e) A particle of unit mass moves in a potential, $v(x) = ax^2 + \frac{b}{x^2}$, where a and b are the constents. Prove that angular frequency of small oscillations about the minimum of the potential is $\sqrt{8a}$.

(f) A bead moves on a circular wire. Specify the type of constraint. 2

(g) Write down the expression of Lienard-Wiechert potential of a moving point charge.

(h) Represent Lorentz transformation in matrix from. 2

(i) What do you mean by cyclic coordinate?

(j) For the Hamiltonian $H = \frac{1}{2}\left(\frac{1}{q^2} + \frac{p^2}{q^4}\right)$, find the equation of motion for q.

(l) Write down the number of degree of freedom of CO_2 molecule.

(m) Write the Lagrrange's equation of motion of Atwood's machine with m_1 and m_2 as masses suspended by the thread of length l and that passes over a smooth fixed pulley.

(n) Two photons approach each other. What is their relative velocity? Give the explanatioin.

(o) Write down the Hamilton's principle.

Group -B

Answer any four questions from the following : 4×5=20

2. (a) Derive Hemitton's equation of motion in tems of Posson bracket from.

   (b) Write down Poisson's theorem. 3+2

3. Find the lagranigian and equation of motion for a bead slides on a wire with shape of cycloid, described by equations :

   $x=a(\theta-\sin\theta)$, $y=a(1+\cos\theta)$ where $0\leqslant\theta\leqslant2\pi$.

4. (i) Give difference between real fluid and ideal fluid.

   (ii) Deduce Stoke's law by thhe method of dimension in the case of a small sphere falling through a viscous fluid. 2+3

5. "Two events are simultaneous, this simultaneisty is relative", explain.

   Write down Lorentz transformation equations. 3+2

6. (a) What is generalised coordinate and generalised momentum?

(b) A pion at rest decay into muon and neutrino. Show that the momentum of the muon is given by

$$|\vec{p}_\mu| = \frac{c(m^2_\pi - m^2_\mu)}{2m_\pi}$$

Where m_π and m_μ are the rest masses of pion and muon. 2+3

7. (a) Using velocity addition theorem, show that the velocity of light in any inertial frame is same. 2

(b) Suppose m_0 is the mass of particle in rest frame. It if moves in a straight line with the velocity v, show that the momentum p can be given by

$$p = \frac{m_0 v}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Group - C

Answer any two questions. **2×10=20**

8. Obrain the Lagrange's equation of motion using D'Alembert's principle. Show that if the Lagrangian does not depend explicity on time, then the total energy is conserved. 6+4

(a) Determine the length of a rod (proper length 100 cm) moving with a velocity of 0.8c in a direction inclined at an angle of 60° to its own length.

(b) An excited atom of mass m_0 is at rest in a certain frame of reference. It is emits a photon and thereby lose an internal energy ΔE. Considering the recoil of at atom, show that the frequency of the emitted photon is

$$\nu = \frac{\Delta E}{2\pi\hbar}\left(1 - \frac{\Delta E}{2m_0c^2}\right)$$

(c) Consider a particle under central force.

A. Write down the Lagrangian of the system and find the equation of motion.

B. Show that the angular momentum of the system is conserved.

C. Find the effective potential for such system.

[3+3+(2+1+1)]

10. (a) What is Bernoulli's theorem. What are meant by static head, dynamic head and gravity head? Show hoe Bernoulli's theorem is related to conservation theorem?

(b) Establish Torricelli's theorem. 2

(c) A horizontal tube has radii 0.5 cm and 0.3 as at two places. For flowing water, the pressure difference at the two places is 1 cm of water. What is the rate of flow?

11. (a) Using Posson bracket, show that the following transformation is canonical.

$Q=(e^{-2q}-p^2)^{1/2}$

$P=\cos^{-1}(Pe^{q})$

(b) P, Q, R be any three dynamical variables, then prove the Jacobi's idenfity that states that

$[P,[Q,R]]+[Q,[r,P]]+[R,[P,Q]]=0$

where P, Q, R are functions of of generalised coordinates and generalised momentum.

(c) Show that the kinetic energy of a particle of rest mass m_0 and moving with velocity v is given by

$$T=m_0c^2\left[\left(1-\frac{v^2}{c^2}\right)^{-1/2}-1\right]$$