

Total No. of Printed Pages—7

5 SEM TDC DSE PHY (CBCS) 1 (H)

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PHYSICS

(Nov/Dec)

(Discipline Specific Elective)

(For Honours)

Paper : DSE-1

(Classical Dynamics)

Full Marks : 80

Pass Marks : 32

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

1. Choose the correct answer : 1×8=8

(a) In classical mechanics, the motion of a charged particle in a uniform magnetic field is

(i) linear

(ii) helical

(iii) parabolic

(iv) None of the above

(2)

- (b) Generalized coordinates are used to describe a system with
- (i) constraints
 - (ii) infinite degrees of freedom
 - (iii) only Cartesian coordinates
 - (iv) None of the above
- (c) In Lagrange's equations, the term involving the time derivative of the Lagrangian with respect to velocity is
- (i) generalized force
 - (ii) kinetic energy
 - (iii) momentum
 - (iv) None of the above
- (d) The configuration space for a system is defined by its
- (i) velocities
 - (ii) generalized coordinates
 - (iii) forces
 - (iv) None of the above
- (e) In special relativity, the invariant interval ds^2 is given by
- (i) $c^2 dt^2 - dx^2 - dy^2 - dz^2$
 - (ii) $dt^2 - dx^2 - dy^2 - dz^2$
 - (iii) $c^2 dt^2 + dx^2 + dy^2 + dz^2$
 - (iv) None of the above

(3)

- (f) A four-vector in Minkowski space that is time-like satisfies
- (i) $ds^2 > 0$
 - (ii) $ds^2 < 0$
 - (iii) $ds^2 = 0$
 - (iv) None of the above
- (g) The four-momentum p^μ for a particle is
- (i) $(E/c, p_x, p_y, p_z)$
 - (ii) (E, p_x, p_y, p_z)
 - (iii) (m, p_x, p_y, p_z)
 - (iv) None of the above
- (h) In fluid dynamics, streamline flow is characterized by
- (i) chaotic motion
 - (ii) constant velocity layers
 - (iii) high Reynolds number
 - (iv) None of the above

2. (a) Describe the motion of a charged particle in a uniform electric field. 4
- (b) Define generalized coordinates. Obtain the expression for kinetic energy in terms of generalized coordinates. 1+2=3

(4)

Or

Find Lagrange's equation of motion for a simple pendulum of length l and mass m .

3

- (c) State Hamilton's principle and use it to find the equation of motion for a simple harmonic oscillator.

3

3. (a) Derive Hamilton's equations of motion from the Lagrangian.

4

Or

For a particle in a central force field, show conservation of angular momentum using the Lagrangian formulation.

- (b) Explain a cyclic coordinate in the context of Lagrangian mechanics.

2

- (c) Discuss one advantage of the Hamiltonian approach over the Lagrangian approach.

2

- (d) Using the concept of Hamiltonian, discuss the motion of a particle under an inverse square law force.

5

(5)

Or

A particle moves under a force $F = -kr$, where r is the position vector.

- (i) Is angular momentum conserved? Explain.

- (ii) Find the orbit equation using Lagrange's equations. 2+3=5

4. (a) Using a potential energy curve, explain stable equilibrium. 3

- (b) What are normal modes? Discuss normal modes for two-coupled pendulums. 2+4=6

Or

Two masses m and $2m$ are connected by a spring of constant k on a frictionless surface. Find the normal frequencies of oscillation.

5. (a) Write the postulates of special theory of relativity. 2

- (b) Write short notes on any two of the following : 3×2=6

- (i) Time dilation
(ii) Four-velocity
(iii) Light cone

(6)

Or

Two observers A and B are moving relative to each other at $v = 0.6c$. If A measures an event duration of 10s, what does B measure?

6

(c) If two events are simultaneous in one inertial reference frame, will they also appear simultaneous in another reference frame moving at constant velocity relative to the first?

3

(d) Write expressions for relativistic energy and relativistic momentum.

1+1=2

6. (a) Derive the expression for four-velocity in special theory of relativity.

4

(b) Explain the energy-momentum four-vector and its invariant.

4

Or

A particle has rest mass m and moves at $0.8c$. Calculate its relativistic energy and momentum in terms of m and c .

(c) What is a space-time diagram? Draw and explain a world line for a particle at rest.

2+3=5

7. Derive the relativistic Doppler effect for light approaching an observer.

5

(7)

Or

A star emits light at 600 nm, observed on Earth at 650 nm. Find the recessional velocity. (Use $c = 3 \times 10^8$ m/s)

8. (a) Define pressure in a fluid. Explain why thrust on a surface is perpendicular to it.

1+1+1=3

(b) Distinguish between laminar and turbulent flow.

2

(c) Derive the continuity equation for fluid flow. For a pipe narrowing from radius $2r$ to r , if velocity at wider end is v , find velocity at narrower end.

4
