SD PHY—01

5th Semester Examination, 2021

Answer any **one** Group as per your Syllabus

Answer from **all** the Parts as per direction

The figures in the right-hand margin indicate marks

Candidates are required to answer in their own words as far as practicable

GROUP – A

(MODEL SYLLABUS)

Time : 3 hours

Full Marks : 60

(CLASSICAL DYNAMICS)

PART – I

1. Answer *all* questions : 1×8

(*a*) Generalized co-ordinates of a system of degrees of freedom n is given by _____.

(*b*) Virtual work δW = _____.

(*c*) Hamiltonian (H) in terms of Lagrangian L is _____.

(*d*) The action integral J = _____ ?

(*e*) _____ is absolute in special theory of relativity.

(*f*) According to mass energy relation E = _____.

(*g*) Minkowski space is a _____ dimensional space.

(*h*) The forward light cone represents _____.

PART – II

2. Answer any *eight* of the following : $1\frac{1}{2} \times 8$

(*a*) Write the expression for generalized displacement.

(*b*) Write the expression for Lagrangian 'L' for a particle moving in a plane.

(c) Write the principle of virtual work.

(d) State Hamilton's principle.

(e) What is the physical significance of Hamiltonian function ?

(f) Calculate the reduced mass of a two body system of mass 1 gm and 2 grams.

(g) State the postulates of special theory of relativity.

(h) Draw a light cone.

(i) What are four vectors ?

(j) What is Doppler's effect ?

PART – III

3. Answer any *eight* of the following : 2×8

(a) Find the expression for generalized force.

(b) Set up Lagrangian for a simple pendulum.

(c) What is a compound pendulum ? Give an example.

(d) Calculate the shortest distance between two points in a plane.

(e) If Lagrangian of a particle of mass 'm' is expressed as

$$L = \frac{p_x^2}{2m} - \frac{1}{2}Kx^2, \quad K\text{-force constant}$$

Then find the Hamiltonian.

(f) Show that central force is conservative,

(g) Explain the application of intigrable power law potential.

(h) Write Lorentz transformation equations.

(i) Explain variation of mass with velocity.

(j) State and explain conservation of four momentum.

PART – IV

Answer **all** of the following questions : 6 × 4

4. Derive Lagrange's equation from D'Alemberts principle.

Or

Apply Lagrange's equation to explain Atwoods machine.

5. Derive Euler-Lagrange's equation from Hamilton's principle.

Or

Discuss the motion of a changed particle in an external electric and magnetic field.

6. Using Lorentz transformation equation, discuss Length contraction and time dilation.

Or

Discuss the different regions of a light cone in space time diagram.

7. Discuss the four vectors and the conservation principle.

Or

Discuss Doppler's effect using four vectors.

GROUP – B

(OLD SYLLABUS)

Time : 3 hours

Full Marks : 80

(CLASSICAL DYNAMICS)

PART – I

1. Answer *all* questions : 2 × 8

(*a*) The Lagrangian is given by

$$L = \frac{1}{2} n \left(\dot{r}^2 + r^2 \dot{\theta}^2 \right) - K / r$$

find the expression for generalized moments.

(*b*) Give the advantage of Hamiltonian approach over Lagrangian approach.

(*c*) If the Lagrangian of a system is given as

$$L = a\dot{x}^2 + b\dot{y}^2 - Kxy.$$

Find the Hamiltonian.

(*d*) What is Hamiltonian ? Give it's physical significance.

(*e*) Show that Lorentz transformation reduce to Gallilean transformation under the condition $V << C$.

(*f*) What do you understand by a light cone ?

(*g*) What do you mean by alternating Tensor ?

(*h*) What is Twin Paradox ?

PART – II

Answer **all** questions : 16×4

2. (*a*) State and explain Hamilton's principle. Derive Lagrange's equation from it. 2 + 8

(*b*) Show that the shortest path between two points in 3-D space is a straight line. 6

Or

(*a*) What do you mean by generalised co-ordinates ? Mention the advantages of using them. 4

(*b*) Give the generalised co-ordinates and set up the Lagrangian in case of 4 + 4 + 4

(*i*) Simple pendulum

(*ii*) Spherical pendulum

(*iii*) An Isotropic oscillator.

3. Obtain the Hamiltonian and the Hamilton's equation of motion for a changed particle in an external electromagnetic field. 16

Or

(*a*) Derive the Hamilton's equation of motion. 8

(*b*) Obtain the Hamilton's equations of motion in spherical and cylindrical co-ordinates. 4 + 4

4. (*a*) Give the postulates of special theory of relativity. 2

(*b*) Derive the Lorentz transformation equations. 8

(*c*) Show that the De-Alembartion operator is invariant under Lorentz transformation. 6

Or

(*a*) Deduce the formula for addition of velocities in relativistic mechanics. Show that when velocity of light is added to the velocity of light we obtain the velocity of light. 8

(*b*) What is meant by relativistic length contraction and time dilation ? Discuss. 4 + 4

5. (*a*) What are four vectors in special theory of relativity ? What are their importance ? Discuss how they transform under Lorentz transformation. 8

(*b*) From conservation of four momentum obtain the energy momentum relation. 8

Or

Derive the Relativistic equation of Doppler effect using four vector method. Explain what is Blue-shift and what is Red-shift. 10 + 6
