

63/1 (SEM-6) DSE3/PHYHE6036

2024

PHYSICS

Paper : PHYHE6036

(Classical Dynamics)

Full Marks : 80

Pass Marks : 32

Time : Three hours

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

1. Choose the correct answer (**any six**): 1×6=6
- (a) The law of conservation of linear momentum is derived from
- (i) First law
 - (ii) Second law
 - (iii) Third law
 - (iv) It has no concern with Newton's law

- (b) The rate of change of angular momentum is called
- (i) kinetic energy
 - (ii) linear momentum
 - (iii) force
 - (iv) torque
- (c) Constraint in a rigid body is
- (i) holonomic
 - (ii) nonholonomic
 - (iii) scleronomic
 - (iv) None of the above
- (d) Generalised co-ordinates are
- (i) dependent of each other
 - (ii) independent of each other
 - (iii) necessarily be spherical co-ordinates
 - (iv) surely be Cartesian co-ordinates

Contd.

(e) The Lagrangian of a system describes the motion of

- (i) a harmonic oscillator
- (ii) an anharmonic oscillator
- (iii) a damped harmonic oscillator
- (iv) a system with unbound motion

(f) If for a harmonic oscillator,

$T \rightarrow$ Kinetic energy

$V \rightarrow$ Potential energy

$L \rightarrow$ Lagrangian

$H \rightarrow$ Hamiltonian,

then choose the correct relation :

(i) $L = V - T, H = V + T$

(ii) $L = T - V, H = T + V$

(iii) $L = T + V, H = T - V$

(iv) $L = VT, H = V - T$

(g) A force, directed always away or towards a fixed point and is a function of the distance from the fixed point is called

- (i) Coriolis force
- (ii) Central force
- (iii) Centripetal force
- (iv) Centrifugal force

(h) The areal velocity of a planet in terms of angular momentum L and reduced mass μ is given by

(i) L/μ

(ii) $L/2\mu$

(iii) $2L/\mu$

(iv) $\sqrt{2\mu L}$

(i) An example of stable equilibrium is

(i) a book placed flat anywhere on the table

(ii) an egg standing on one end

(iii) a pendulum in the rest position

(iv) None of the above

(j) A particle is moving under a central force. Which of the following physical quantities remains constant?

(i) Linear momentum

(ii) Kinetic energy

(iii) Angular momentum

(iv) Work

2. Answer the following questions: **(any five)**

2×5=10

(a) What are constraints? Explain.

(b) Define gyroradius and gyrofrequency.

(c) What is the Hamiltonian function?

(d) What are coupled Oscillators?

(e) What are inertial and non-inertial frames of reference?

(f) What is time dilation?

(g) What is Reynold's number?

3. Answer the following questions: **(any six)**

5×6=30

(a) Derive Navier-Stokes equations.

(b) What are generalised co-ordinates? Describe the advantage of using generalised co-ordinates in solving mechanical problems.

(c) Deduce general form of Lagrange's equation.

(d) Deduce Hamilton's equation for simple harmonic oscillations.

(e) Briefly discuss the Lagrangian formulation of small oscillation.

(f) What is a rigid body? Obtain Euler's equation of motion for a rigid body.

(g) Discuss the principle of relativity and the invariance of speed of light.

(h) Derive the expressions for the Lorentz space-time transformation.

(i) Deduce continuity equation for a flow of liquid.

(j) Establish Navier-Stokes equation.

4. Answer the following questions : **(any two)**

10×2=20

- (a) Show that Lagrange's equation is invariant under Galilian transformation.
- (b) Derive the Euler-Lagrange equations of motion using the calculus of variations and hence obtain Lagrange's equation of motion for a system of particles.
- (c) Discuss one experiment in support of time dilation in special relativity.
- (d) Deduce Poiseuille's equation for a flow of a liquid through a pipe.

5. Answer the following question : **(any one)**

14×1=14

(a) Write short notes on —

- (i) four momentum and energy-momentum relation
- (ii) Lorentz transformations

- (b) Obtain the Lagrangian equation of motion for a free particle in cylindrical and spherical polar co-ordinates.
- (c) What is D'Alembert's principle? Derive Lagrange's equations of motion from it for conservative system.