



2022/TDC/ODD/SEM/PHSDSE-501T/157

TDC (CBCS) Odd Semester Exam., 2022

PHYSICS

(5th Semester)

Course No. : PHSDSE-501T

(Classical Dynamics)

Full Marks : 70

Pass Marks : 28

Time : 3 hours

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

UNIT—I

1. Answer any *four* as directed : $1 \times 4 = 4$

(a) The centre of mass of a body may lie within or outside the body.

(State true or false)

(b) Does centre of mass depend on relative distance between the particles?

(c) What do you mean by constrained motion?



(2)

- (d) The number of degrees of freedom
- (i) is minimum independent variables
 - (ii) is maximum independent variables
 - (iii) may be minimum or maximum number of variables
 - (iv) Cannot say

(Choose the correct one)

- (e) The angular momentum is _____ in a central force field.

- (i) zero
- (ii) infinity
- (iii) conserved
- (iv) not conserved

(Choose the correct one)

2. Answer any one question : 2

- (a) Show that centre of mass of two particles of same mass lies in the midway of both.
- (b) Write few characteristics of central force.

3. Answer any one question : 8

- (a) (i) Show that the central force is a conservative force. 3
- (ii) Obtain the differential equation of motion for a central force field. 5

(3)

- (b) (i) State three Kepler's laws of planetary motion. 3

- (ii) Two point masses 3 kg and 5 kg are located at 4 m and 8 m respectively from the origin on X-axis. Find the position of centre of mass of the point masses from the origin and also from 3 kg mass. $2\frac{1}{2} + 2\frac{1}{2} = 5$

UNIT—II

4. Answer any four as directed : 1×4=4

- (a) Generalised coordinates
- (i) depend on each other
 - (ii) independent of each other
 - (iii) necessarily spherical coordinates
 - (iv) None of the above

(Choose the correct one)

- (b) What is the order of Lagrange's equation of motion?

- (c) If Lagrangian does not depend on time explicitly, kinetic energy becomes constant. (State true or false)

- (d) State de Alembert's principle.

- (e) Name the constraints which are independent of time.



(4)

5. Answer any one question : 2

- (a) What are conservative and dissipative constraints?
- (b) State Hamilton's principle.

6. Answer any one question : 8

(a) Derive Lagrange's equation of motion for a conservative system from de Alembert's principle.

(b) (i) What are the advantages of Lagrangian formulation? 3

(ii) A particle moves in one dimension such that the Lagrangian is given by $L = \frac{1}{2}m^2\dot{x}^4 + m\dot{x}^2v - v^2$, where v is a function of x . Show that the equation of motion is $m\ddot{x} + \frac{\partial v}{\partial x} = 0$. 5

UNIT—III

7. Answer any four as directed : 1×4=4

- (a) If Lagrangian does not depend on time explicitly, Hamiltonian becomes constant. (State true or false)
- (b) When does Hamiltonian equal total energy of a system?

(5)

(c) State the law of conservation of angular momentum.

(d) Write the Hamilton's canonical equations of motion.

(e) Why are Hamilton's canonical equations so named?

8. Answer any one question : 2

(a) Show that angular momentum of a particle in a central force field remains constant.

(b) For the Lagrangian $L = a\dot{x}^2 + b\dot{y}^2 - Kxy$, show that the Hamiltonian is given by

$$H = \frac{p_x^2}{4a} + \frac{p_y^2}{4b} + Kxy$$

9. Answer any one question : 8

(a) (i) Deduce Hamilton's canonical equations of motion. 3

(ii) Obtain the Hamiltonian and Hamilton's equations of motion for a one-dimensional harmonic oscillator. 5

(b) (i) Show that the total energy of a particle is conserved if it moves in a central force field. 5



(6)

- (ii) Write the Lagrangian of a one-dimensional harmonic oscillator and hence obtain the corresponding Hamiltonian. 3

UNIT—IV

10. Answer any four as directed : 1×4=4

- (a) What do you mean by small oscillation?
- (b) Give an example of unstable equilibrium.
- (c) Define equilibrium in the context of oscillation.
- (d) In terms of normal coordinates, both kinetic and potential energy terms are diagonal. (State true or false)
- (e) The displacement of a particle in SHM of amplitude A in one time period is
 - (i) zero
 - (ii) $4A$
 - (iii) $2A$
 - (iv) A (Choose the correct one)

11. Answer any one question : 2

- (a) What are the differences between stable and unstable equilibrium?

(7)

- (b) Write down the conditions of stable and unstable equilibrium. 8
12. Answer any one question : 8
- (a) (i) Expand potential energy around a minimum. 3
 - (ii) Calculate the frequency of vibration of a diatomic molecule. 5
 - (b) (i) Show that a simple pendulum can oscillate about the position of its stable equilibrium. 4
 - (ii) Find the points of stable and unstable equilibrium for a given potential 4
- $$V(x) = x^4 - 4x^3 - 8x^2 + 48x$$

UNIT—V

13. Answer any four as directed : 1×4=4

- (a) Which instrument is used to measure pressure?
- (b) Plants get water through the roots by action of
 - (i) capillary
 - (ii) viscosity
 - (iii) gravity
 - (iv) osmosis (Choose the correct one)



(8)

(c) The viscous force always opposes the relative motion between the two adjacent layers of a fluid in motion. (State true or false)

(d) The viscosity of a fluid in motion is 1 poise. What will be its viscosity when the fluid is at rest?

(e) In fluid motion, the equation of continuity is based on conservation of _____. (Fill in the blank)

14. Answer any one question :

2

(a) Define field of flow and line of flow of fluids.

(b) Define an ideal fluid. Give an example of ideal fluid.

15. Answer any one question :

8

(a) Define coefficient of viscosity. Find its dimension. Deduce Poiseuille's equation.

$$1+1+6=8$$

(b) Deduce equation of continuity. Write its significance. Write down the forms of continuity equation for streamline motion and also for incompressible fluids.

$$4+2+1+1=8$$
