

SEAT No. _____

[70]

SADAR PATEL UNIVERSITY**Fifth Semester B. Sc. Examination (NC)**Saturday, 4th October 2025

Time: 10:00 am to 1:00 pm

PHYSICS: US05CPHY21 (Classical Mechanics)**Total Marks: 70****Note: All the symbols have their usual meaning.****Que-1****Choose the correct option to answer the question.****[10]**

- (1) A particle moving on a sphere is an example of _____ motion.
(a) jumping (b) constrained motion (c) orbital (d) linear
- (2) Work done by the force of constraint is _____.
(a) Zero (b) infinity (c) negative (d) unit
- (3) The momentum conjugates to a cyclic coordinate is _____.
(a) always unity (b) not conserved (c) function of time (d) conserved
- (4) Non-accelerated frame of reference is called _____ frame of reference.
(a) non-inertial (b) inertial (c) rotational (d) vibrational
- (5) _____ is the same in fixed and rotating coordinate system.
(a) linear acceleration (b) velocity
(c) angular acceleration (d) momentum
- (6) The distance between any two particles of a _____ is constant.
(a) gaseous body (b) rigid body (c) flexible body (d) liquid
- (7) a configuration space can have _____ dimensions.
(a) n (b) Always three (c) zero (d) Two dimensions only
- (8) The formula for the straight distance 'ds' between two points in a plane is _____.
(a) $dx + dy$ (b) $(dx^2 + dy^2)^{\frac{3}{2}}$ (c) $\sqrt{dx + dy}$ (d) $\sqrt{dx^2 + dy^2}$
- (9) Hamilton's function is related to the Lagrangian function as,
(a) $H = \sum p_i \dot{q}_i - L(q_i, \dot{q}_i, t)$ (b) $H = L + \frac{df}{dt}$
(c) $H = L(q, \dot{q}, t) + \frac{d}{dt} F(q, Q, t)$ (d) $H = \sum p_i - L$
- (10) $p_k = Q_k$ and $P_k = q_k$ are _____ transformation for generating function
 $F = \sum q_k Q_k$
(a) inverse (b) canonical (c) exchange (d) Hermitian



Que-2

Answer briefly any ten of the following questions.

[20]

- (1) What are the requirements of generalized coordinates?
- (2) What are constraints? Give any two examples of equations of constraints.
- (3) Define holonomic and non-holonomic constraints.
- (4) What does a rigid body mean? Is it possible to have a perfectly rigid body?
- (5) Explain briefly weight less condition of an observer in a satellite.
- (6) Write the statement of Chasle's theorem.
- (7) Briefly discuss configuration space and define system point.
- (8) What is constraint motion? Define constraints.
- (9) What are advantages of Hamilton's formulations over Newtonian formulation?
- (10) Show that cyclic coordinate in Lagrangian will also be absent in Hamiltonian.
- (11) What is identity transformation?
- (12) Write down Importance of Poisson's Brackets

Que-3

- (a) Obtain D' Alembert's principle.

[06]

- (b) Show that momentum conjugate to cyclic coordinate is conserved.

[04]

OR

Que-3

- (a) Discuss Atwood machine and derive equation of motion of the machine and obtain its equation of motion as;

[06]

$$x = x_0 + v_0 t - \frac{1}{2} \left(\frac{m_1 - m_2}{m_1 + m_2} \right) g t^2$$

- (b) Show that energy dissipated is twice of Rayleigh dissipation function

[04]

Que-4

- (a) If $O'(x', y', z')$ and $O(x, y, z)$ are fixed and rotational coordinate systems respectively then for a vector $\vec{V}$ obtain;

[06]

$$\left(\frac{d\vec{V}}{dt} \right)_{fix} = \left(\frac{d\vec{V}}{dt} \right)_{rot} + \vec{\omega} \times \vec{V}$$

- (b) Explain the effect of Coriolis force on a freely falling body under the action of gravity.

[04]

OR

- Que-4 (a) Write down the statement of Euler's theorem and explain it. [06]
(b) Obtain Euler's Equations of Motion for a rigid body as, [04]

$$N_1 = I_1 \dot{\omega}_1 + (I_3 - I_2) \omega_2 \omega_3$$

$$N_2 = I_2 \dot{\omega}_2 + (I_1 - I_3) \omega_1 \omega_3$$

$$N_3 = I_3 \dot{\omega}_3 + (I_2 - I_1) \omega_1 \omega_2$$

- Que-5 (a) Obtain the following Euler's equation. [06]

$$\frac{\partial f}{\partial y} - \frac{d}{dx} \left(\frac{\partial f}{\partial y'} \right) = 0$$

- (b) Draw an electrical circuit containing an inductor (L), a capacitor (C), and a resistor (R) in parallel combination. Analyze it using the Lagrangian formulation [04]

OR

- Que-5 (a) Obtain Hamilton's principle from Newton's equations. [06]

- (b) Using the Variational principle, show that the shortest distance between two points in a plane is a straight line. [04]

- Que-6 (a) Obtain following Hamilton's canonical equations of motion for a system of n-particles. [06]

$$\dot{q}_k = \frac{\partial H}{\partial p_k} \quad \& \quad -\dot{p}_k = \frac{\partial H}{\partial q_k}$$

- (b) Discuss Gauge Transformation. [04]

OR

- Que-6 (a) Using definition of Poisson's bracket prove that, [06]

$$[u, [v, w]] + [v, [w, u]] + [u, v], w = 0$$

- (b) Prove the following properties of Poisson's brackets. [04]

(i) $[u, u] = [v, v] = 0$, (ii) $[u, c] = 0$ (where c is a constant)

