

Reg. No. :

Name :

Fourth Semester B.Sc. Degree Examination, May 2021

First Degree Programme under CBCSS

Physics

Core Course III

PY 1441 : CLASSICAL AND RELATIVISTIC MECHANICS

(2018 Admission)

Time : 3 Hours

Max. Marks : 80

SECTION – A

Answer **all** questions in **one** or **two** sentences.

Each question carries **1** mark.

1. Define degree of freedom of a dynamical system.
2. State Principle of relativity.
3. What do you mean by cyclic coordinates?
4. Define Hamiltonian H . Give its physical significance.
5. Define central force.
6. What is meant by first integrals?
7. What is meant by Lorentz-Fitzgerald contraction?
8. A particle is constrained to move along the inner surface of a fixed hemispherical bowl. What will be its number of degrees of freedom?

9. If e is the eccentricity of the earth's orbit, what will be the ratio of maximum and minimum speeds of the planet?
10. What are holonomic and nonholonomic constraints?

(10 × 1 = 10 Marks)

SECTION – B

Answer any **eight** questions; not exceeding a paragraph.

Each question carries **2** marks.

11. What are inertial frames of reference? Give an example.
12. State D'Alembert's principle. Discuss its significance.
13. A particle moving under the influence of inverse square law of force has energy greater than zero. What will be the motion of the particle? Briefly explain.
14. What are generalized co-ordinates? What is its importance?
15. Show that a conservative force can be expressed as the gradient of potential.
16. Show that acceleration is invariant under Galilean transformation.
17. State the principle of virtual work.
18. Explain twin paradox in special relativity.
19. State Kepler's laws of planetary motion.
20. What are the consequences of Lorentz transformations?
21. What are constraints? Classify the constraints with some examples.
22. What do you understand by proper length and proper time interval?

(8 × 2 = 16 Marks)

SECTION – C

Answer any **six** questions; not exceeding a paragraph.

Each question carries **4** marks.

23. Deduce Newton's law of gravitation from Kepler's laws.
24. In the Michelson-Morley experiment, what is the expected fringe-shift, if the effective length of each path is 6 meters and light has $6000 \text{ \AA}$ wave-length? (speed of earth $v = 3 \times 10^4 \text{ m/sec.}$)
25. Show by direct application of Lorentz transformations that $x^2 + y^2 + z^2 + w^2$ is invariant, where $w = ict$.
26. Write down the Hamiltonian for a one-dimensional harmonic oscillator and deduce its equations of motion.
27. State and prove the conservation theorem of linear momentum for a system of N particles.
28. Prove that the generalized momentum conjugate of a cyclic coordinate is conserved.
29. Prove that the Hamiltonian H of a conservative system is equal to the total energy of the system.
30. Obtain the equation of motion of a system of two masses, connected by an inextensible string passing over a small smooth pulley.
31. Find the Lagrangian for the case when the Hamiltonian is $H(p, r) \frac{p^2}{2m} = (a \cdot p)$, $a = \text{constant}$.

(6 × 4 = 24 Marks)

SECTION – D

Answer any **two** questions; not exceeding a paragraph.

Each question carries **15** marks.

32. Derive Lagrangian equation of motion using D'Alembert's principle.
33. Describe the Michelson-Morley experiment and explain the physical significance of negative result.

34. Using the principle of classical mechanics, prove the law of conservation angular momentum, Kepler's second law and derive the differential equation of the orbit in the central force field.
35. (a) Define generalized momentum and cyclic coordinates. Show that the generalized momentum corresponding to a cyclic coordinate remains conserved.
- (b) Hence prove the law of conservation of momentum for a system of particles. What is the relation between this law and symmetry properties of the system?

(2 × 15 = 30 Marks)