

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2023**  
**(Regular/Improvement/Supplementary)**

**PHYSICS**  
**FPHY1C01-CLASSICAL MECHANICS**

**Time: 3 Hours**

**Maximum Weightage: 30**

**Part A: Short answer questions. Answer *all* questions. Each carries *one* weightage.**

1. What do you mean by constraints? How do holonomic constraints affect the degree of freedom of a system?
2. Express Hamilton's equations of motion in Poisson bracket form.
3. Write the Lagrange's equation of motion of a simple pendulum. Show that its oscillation is simple harmonic for small oscillations.
4. Explain centrifugal and coriolis forces.
5. What do you mean by universality of chaos?
6. Explain body set of axes and space set of axes. Name any one method to transform coordinates between these axes.
7. Obtain the Lagrangian of a linear triatomic molecule.
8. Explain stable and unstable equilibrium with the help of potential energy curves.

**(8 × 1 = 8 weightage)**

**Part B: Essay questions. Answer any *two* questions. Each carries *five* weightage.**

9. Discuss motion in time in Kepler problem and hence deduce Kepler's third law of motion (assume the time equation in general central force problem).
10. Explain canonical transformation. Discuss different types of generating functions and obtain the equations of motion in terms of generating functions.
11. Derive the Euler's equations of motion of a rigid body rotating about a point. Hence obtain the equations for torque free motion. Show that rotational kinetic energy is conserved in torque free motion.
12. Explain Logistic map. Discuss fixed points and period doubling bifurcation with respect to Logistic map.

**(2 × 5 = 10 weightage)**

**(P.T.O.)**

**Part C: Problems. Answer any four questions. Each carries three weightage.**

13. Derive Lagrange's equation from Hamilton's principle.
14. The Hamiltonian of a system is  $H = \dot{x}^2 + \dot{x} + x$ . Find the corresponding Lagrangian.
15. Show that the transformation  $Q = \log\left(\frac{1}{q} \sin p\right)$  and  $P = q \cot P$  is canonical.
16. By using the method of action angle variables, show that the angular frequency of a simple pendulum is  $\sqrt{\left(\frac{g}{l}\right)}$ .
17. A rigid body consists of three particles of each of mass 1 kg located at points (1,0,1)m, (0,1,1)m, (2,0,3)m. Determine the moment of inertia tensor of the body.
18. A particle of unit mass moves in a potential  $V(x) = 16x + \frac{1}{x^2}$ . Find the angular frequency of small oscillations of the particle about the minimum of the potential.
19. Write notes on: i) Chaos; ii) Attractors; iii) Limit cycles.

**(4 × 3 = 12 weightage)**