

**Exam. Code : 209001**

**Subject Code : 4764**

**M.Sc. Physics 1<sup>st</sup> Semester**  
**CLASSICAL MECHANICS**  
**Paper-PHY-403**

Time Allowed—3 Hours] [Maximum Marks—100

**Note :—** Attempt **five** questions, selecting at least **one** question from each section. The **fifth** question may be attempted from any section. All questions carry equal marks.

**SECTION-A**

- I. (a) State D'Alembert principle and hence derive Lagrange's equations of motion for a conservative system having holonomic constraints imposed on it. 14
- (b) Obtain Lagrangian and equation of motion for Atwood machine. How these expressions get modified when the pulley has finite mass ? 6
- II. (a) State the generalized momentum conservation theorem for cyclic coordinates. Hence deduce linear and angular momentum conservation theorems from this generalized momentum conservation theorem. 14

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- (b) Discuss the relation between the symmetry properties of the system and conservation laws by citing suitable examples. 6

**SECTION-B**

- III. (a) Obtain the equations of motion, their first integrals and complete solutions analytically for the motion of a particle subjected to a central force field. 10
- (b) A particle subjected to central force field describes an orbit whose equation is  $r = C \theta$ , where  $C$  is constant. Deduce the force law and energy of the particle. http://www.gnduonline.com 10
- IV. Obtain equation for orbit of a particle moving under the influence of an inverse square central force field. Also prove that semi-major axis depends only upon energy for elliptical orbit and hence obtain its eccentricity. 20

**SECTION-C**

- V. (a) State and prove Euler's theorem for the motion of a rigid body with one point fixed. 15
- (b) What do you mean by an infinitesimal transformation ? Hence obtain the orthogonal transformation matrix for it. 5

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- VI. (a) What do you mean by inertia tensor, principal axes and the principal moments of inertia ? Obtain these for a system in which the eight balls, having unit mass for each of the ball, are placed at the corners of a cube. 10
- (b) Obtain Euler's equations of motion for a rotating rigid body. What information these equations provide when the motion of the rigid body is not subjected to any force ? 10

#### SECTION-D

- VII. What is  $\Delta$ -variation ? Discuss how it differs from  $\delta$ -variation. State and prove the principle of least action. List its various forms also. 20
- VIII.(a) Define canonical transformations and deduce the condition for a given transformation to be canonical. 8
- (b) Show that following transformation is canonical  $Q = \sqrt{2q} e^{\alpha} \cosh p$ ,  $P = \sqrt{2q} e^{-\alpha} \sinh p$ , where  $\alpha$  is constant. Hence deduce generating function for the transformation. 8
- (c) Define point transformation and Show that  $\sum_j f(q, t) P_j$  is the generating function for this transformation. 4