Exam. Code : 209001
Subject Code : 4764

M.Sc. Physics 1st 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

(b) Discus 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. 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

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 Δ-variation ? Discuss how it differs from δ-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 $Q = \sqrt{2q}\, e^{\alpha} \cos p$, $P = \sqrt{2q}\, e^{-\alpha} \sin p$, where α 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