HR-003-1162006

M. Sc. (Sem. II) Examination

April - 2023

Mathematics : EMT-2001

(Classical Mechanics-II)

Faculty Code : 003
Subject Code : 1162006

Time : $2\frac{1}{2}$ / Total Marks : 70

Instructions : (1) Attempt any five questions from the following.

(2) There are total five questions.

(3) Each question carries equal marks.

1 Attempt the following : (any seven) **14**

(1) State Lorentz – Fitzgerald contraction hypothesis.

(2) State minimum three differences between Newtonian theory and theory of relativity.

(3) Define : Poisson brackets of two functions u and v.

(4) Define : Cyclic co-ordinates.

(5) Define : Proper length and proper time.

(6) State minimum four differences between Lagrangian formulation and Hamiltonian formulation.

(7) State both the postulates of special theory relativity.

(8) Which equations are satisfied by cyclic coordinates in Routh's procedure ?

(9) State only the transformation equations when the generating function is of the type F_3 (p_i, Q_i, t)

(10) State only the Euler's equations for a torque free motion.

2 Attempt the following : (any two)   **14**

   (a) Prove in the usual notations the relation $\overline{L} = I\overline{\omega}$.

   (b) Derive Galilean transformation equations of motion which connects a stationary reference frame S and a moving reference frame S'.

   (c) Prove in the usual notations:

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

3 Attempt the following :   **14**

   (a) Derive Hamilton's canonical equations of motion.

   (b) Express the components of angular velocity ω of a rigid body along what space set of axes in terms of Euler angles.

<p align="center">OR</p>

   (a) Derive Euler's equations of motion for a rigid body with one point fixed.

   (b) An electron is moving with a speed of 0.85c in a direction opposite to that of moving photon. Calculate the relative velocity of electron and photon.

4 Attempt the following :   **14**

   (a) Prove that the moment of inertia about a given axis is equal to the moment of inertia about a parallel axis through the *C.M.* plus the moment of inertia of the body as if concentrated at the center of mass with respect to the original axis.

   (b) (i) Discuss in detail the phenomenon of length contraction.

       (ii) A rod has proper length 2000 m is moving in a space shuttle with velocity 0.8 c. What will be the difference of lengths measured by the observers situated in the (a) laboratory (b) in space shuttle.

5 Attempt the following : (any two)   **14**

   (a) Explain detail the variation of mass with velocity and establish the relation $m = \dfrac{m_0}{\sqrt{1 - \dfrac{u^2}{c^2}}}$.

(b) Obtain Hamilton's principal function for the motion of one dimensional simple Harmonic oscillator and show that the of Hamilton's principal function differs from indefinite time integral of Lagrangian only by a constant.

(c) Prove in the usual notation the relation $E = mc^2$.

(d) Derive the transformation equations, if the generating function is $F_1 (q_i, Q_i, t)$

(e) Discuss in detail the principle of least action.

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