Islampur College

Department of Physics

Home Assignment for Internal Assessment

Sem: IV (Major)

Paper Name: Classical Mechanics-I

Paper Code: PHYSMAJ408

Submission Date: 02/06/2026-03/06/2026

Submission Time: 12:00 PM-2:00 PM

Submission Room Number: 214

Full Marks: 20

Instructions to Students:

- Prepare the home assignment by choosing any one of the following problems (**Problem 1 or Problem 2**). Each problem contains multiple sub-questions. Students must answer all the questions under the selected problem.

Problem 1. (a) Define cyclic coordinates. Show that the generalized momentum conjugate to a cyclic coordinate is conserved. Show that they are more general than the momentum conservation theorem. [2+3+2]

(b) The point of suspension of a pendulum moves in the vertically downward direction with a constant acceleration f. Find the Lagrangian and hence the equation of motion. What will be its period, if downward acceleration f is the same as that due to gravity? [2+2+2]

(c) Write Lagrange's equation of motion of Atwood's machine shown in Figure. 1, with m_1 and m_2 as masses suspended by a thread of length l that passes over a smooth fixed pulley. Hence find the acceleration of the mass m_1. [4+1]

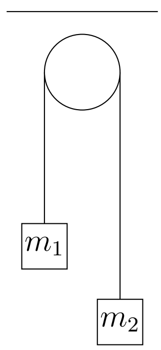

Figure 1: Atwood's machine

(d) What, according to you, is the advantage of Lagrange's method over that of Newton? [2]

Or,

Problem 2. (a) What is an integral of motion? Prove, from Lagrange's equation, that the total linear momentum of a closed system is conserved due to homogeneity of space. [1+4]

(b) Using Hamilton's canonical equations, derive the equation of motion of a particle moving in a force field in which the potential is given by $V = -\frac{k}{r}$, where k is positive. [5]

(c) Show that if the Lagrangian of a system does not depend explicitly on time, the Hamiltonian of the system is a constant of motion. Find the conditions when the Hamiltonian will be the total energy of the system. [3+2]

(d) An incline that makes an angle α with the horizontal is given a horizontal acceleration of magnitude a in the vertical plane of the incline to prevent the sliding of any frictionless block of mass M placed on it. Find the value of a by applying D'Alembert's principle. [3]

(e) If the Lagrangian $L = L_0 + L_1 + L_2 + \cdots$, where L_r is a homogeneous function of degree r in $\dot{q}_i$ with coefficients as any function of q_i, prove that the Hamiltonian $H = -L_0 + L_2 + 2L_3 + \cdots$ [2]

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