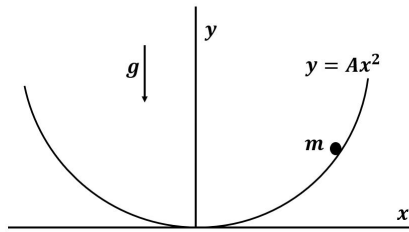


Indian Institute of Information Technology, Allahabad

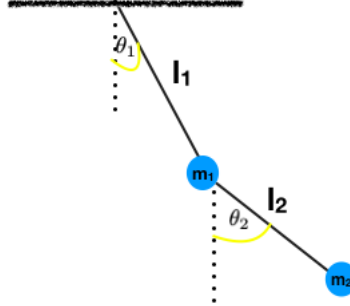
Assignment 1: Engineering Physics, Jan-June Semester 2024

Deadline of Submission: 6.30 PM, 22 February, 2024

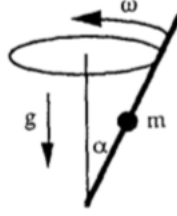
- [1] In the given setup below, A bead, having mass m , slides under gravitational field g without friction along a parabolic wire $y = Ax^2$.
- Determine Lagrangian taking horizontal axis x as a generalised coordinate.
 - Establish Lagrange's equation of motion for the given setup.
 - Find out the Hamiltonian.



- [2] A double pendulum is shown below



- Find the Lagrangian of the system.
 - Find out the Lagrange's equations of motion.
- [3] Find the smooth curve joining two points A and B along which a particle will slide from A to B under gravity in the fastest possible time.
- [4] A bead of mass m slides down on a long straight wire that makes an angle α with the vertical. The wire rotates with a constant angular velocity ω about the vertical. Gravity acts vertically downwards.



- a. Find the Lagrangian of the system.
 - b. Find out the Hamiltonian and Hamilton's equations of motion.
- [5] The phase velocity of ripples on a liquid surface is $\sqrt{\frac{2\pi S}{\lambda \rho}}$, where S is the surface tension and ρ is the density of the liquid. Find the group velocity of the ripples. Express the group velocity in terms of the phase velocity.
6. An electron is in a box of size 0.20 nm. Find its permitted energies.
7. Consider the quantum mechanical particle-in-a-box system with a box of length L .
- a. Evaluate the probability of finding the particle in the interval from $x = 0$ to $x = L/4$ for the system in its n^{th} quantum state.
 - b. Find the expectation values of x and p^2 for the n^{th} quantum state.
8. Obtain the energy states and wavefunction for a particle in a 3-dimensional box whose lengths are L_1 , L_2 , and L_3 . Find the energies for the ground state and the next two excited states.