Indian Institute of Technology Guwahati

Tutorial-4 PH4030: Classical Mechanics Dated 12 Nov 2026

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1. The Lagrangian of a system is given by $L = x^2 + x\dot{x} + \frac{\dot{x}^2}{2}$. If p is the generalised momentum, then find the corresponding Hamiltonian.

2. The Hamiltonian of a system is given as $H = \frac{p^2}{2} - \frac{1}{2q^2}$. If $I = apq + bp^2t + \frac{ct}{q^2}$ is a constant of motion where (a, b, c) are constants, then show that $a = -b = c$.

3. The Hamiltonian of a simple pendulum of mass m attached to a string of length l is given as $H = \frac{P_\theta^2}{2ml^2} + mgl(1 - \cos\theta)$. If L is the Lagrangian of the system, then find $\frac{dL}{dt}$.

4. The Hamiltonian of a simple harminic oscillator is $H(q, p)$ whose Lagrangian is given as $L = \frac{\dot{q}^2}{2} - \frac{q^2}{2}$. If $A(p, q) = \frac{1}{\sqrt{2}}(p + iq)$ then find the Poisson bracket $\{A, H\}$.

5. A particle mass m is moving in a stable, circular orbit or radius r_0 with angular momentum L. If the potential energy $V(r) = \alpha r^k$ where α>0 and k>0, show that for $k = 2$, $r_0 = \{\frac{L^2}{2m\alpha}\}^{1/4}$.

6. A rigid sphere of radius R is scattering a beam of particles. Obtain the differential and total cross section in terms of R.
