

# Notes on Classical Mechanics

Pugazharasu A D

August 22, 2020

**Abstract**

## 1 Hamilton's Principle

$$\delta \int_A^B (T - U) dt = 0 \quad (1)$$

## 2 Generalized Coordinates

## 3 Lagrange's Equations of Motion in Generalized Coordinates

$$\frac{\partial L}{\partial q_i} = \frac{d}{dt} \left( \frac{\partial L}{\partial \dot{q}_i} \right) \quad (2)$$

$$\frac{\partial L}{\partial q_i} = \dot{p} \quad (3)$$

$$p = \frac{\partial L}{\partial \dot{q}_i}$$

- The forces acting on the system (apart from any forces of constraint) must be derivable from potentials
- The equations of constraint must be relations that connect the coordinates of the particles and may be functions of the time

## 4 Harmonic Oscillator

### 4.1

### 4.2

## 5 Lagrange's Equations With Undetermined Multipliers

- The Lagrange multipliers are closely related to the forces of constraint that are often needed
- When a proper set of generalized coordinates is not desired or too difficult to obtain, the method may be used to increase the number of generalized coordinates by including constraint relations between the coordinates

- 6 Equivalence of Lagrange's and Newton's Equations**
- 7 Essence of Lagrangian Dynamics**
  - While Newtonian mechanics , Lagrangian method deals only with quantities associated with the body
- 8 A Theorem Concerning the Kinetic Energy**
- 9 Conservation Theorems Revisited**
  - 9.1 Conservation of Linear Momentum**
  - 9.2 Conservation of Angular**
  - 9.3 Conservation of Energy**
    - The equations of the transformation connecting the rectangular and generalized coordinates must be independent of the time, thus ensuring that the kinetic energy is a homogeneous quadratic function of the  $\dot{q}_i$
    - The potential energy must be velocity independent, thus allowing the elimination of the terms  $\partial U/\partial \dot{q}_i$  from the equations for  $H$ .
- 10 Canonical Equations of Motion - Hamiltonian Dynamics**
- 11 Some Comments Regarding Dynamical Variables and Variational Calculations in Physics**
- 12 Phase Space and Liouville's Theorem**
- 13 Virial Theorem**