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Roll No. ____________

19/572

M.Sc. (First Semester) Examination, 2019

Physics

Second Paper

(Classical Mechanics)

Time : Three Hours *Maximum Marks : 100*

Note : Answer **five** questions in all. Short answer type **question no.1** carrying **40** marks is **compulsory**. Answer **one** question carrying **15** marks from each unit.

The answers to short answer type questions should not exceed 200 words and the answers to long answer type questions should not exceed 500 words.

P.T.O.

1. Give short answers of the following questions : 4×10=40

   (i) Setup the Lagrangian for a simple pendulum and obtain the equation describing its motion.

   (ii) Define generalised co-ordinates and obtain the expression for generalised displacement.

   (iii) What is physical significane of Hamiltonian equations?

   (iv) State and discuss the principle of least action.

   (v) Prove that if there are no forces acting on a rigid body with one point fixed, then the total kinetic energy of rotation is constant. Hence Prove that

   $\vec{\omega}.L = 2T =$ constant

   Where T is the kinetic energy.

(vi) If $[\phi, \psi]$ be poisson bracket then prove that :

$$\frac{\partial}{\partial t}[\phi, \psi] = \left[\frac{\partial \phi}{\partial t}, \psi\right] + \left[\phi, \frac{\partial \psi}{\partial t}\right]$$

(vii) Prove that the transformation

$Q = \log\left(\frac{1}{q}\sin p\right)$ and $P = q \cot p$ is cononical

(viii) Prove that the Poisson Bracket of two constants of motion is itself a constant of the motion.

(ix) Deduce Hamilton-Jacobi Equation.

(x) Define action and angle variable.

Unit-I

2. (a) Obtain the Lagrange's equation of motion using D' Alemberts principle. 7½

(b) Show that if the lagrangian does not depend explicity on time, then the energy is conserved. 7½

P.T.O.

OR

3. Derive Hamilton's equations of motion for a system of particles. Hence write down the equations of motion of a particle in a central force field in space. 15

Unit-II

4. (a) State hamilton's principle and use it to obtain the equation of motion. 7½

$$mf = -\frac{\partial V}{\partial x}$$

for a particle of mass m moving with acceleration f in a potential V.

(b) Show that the shortest distance between two points in a plane is along the straight line joining them. 7½

OR

5. Discuss the force free motion of a symmetrical top for which $I_1 = I_2$. obtain an expression for the frequency of precession about the axis of symmetry. 15

Unit-III

6. (a) What is the condition for a transformation to be canonical? Deduce Hamilton's Canonical equation of motion. 7½

   (b) Prove that the transformation

   $P = \frac{1}{2}\left(p^2 + q^2\right)$ and $Q = \tan^{-1}\left(\frac{q}{p}\right)$ is canonical. 7½

OR

7. (a) Define Poisson's Bracket and prove that Poission – Bracket are invarient under canonical transformation. 7½

   (b) Derive equation of motion in terms of Poisson - Bracket form. 7½

Unit-IV

8. Give an account of the Hamilton Jacobi theory and illustrate it by applying it to the Kepler's problem (particle moving under central force). 15

OR

9. If the Hamiltonian for a simple linear Harmonic oscillator of mass m is given by, 15

$$H = \frac{1}{2}\left(\frac{p^2}{m} + \mu q^2\right),$$

(q, p) being position and momentum co-ordinates of the harmonic oscillator and $\mu = m\omega^2$, the find the corresponding Hamilton-Jacobi equation and determine the motion of the oscillator by using the Hamilton Jacobi method.