M.Sc. (Physics) First Semester Old

0134 - Classical Mechanics Paper-II

P. Pages : 2 | **GUG/W/18/2191**

Time : Three Hours | Max. Marks : 80

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1. Either

a) Explain D'Alembert principle. **4**

b) Starting from D' Alemberts principle derive langrage's equation for conservative system. **8**

c) Find the equation of motion for simple pendulum by using Lagrange's equation. **4**

OR

e) i) What are constraints? Discuss briefly the classification of constraints. **4**

ii) Write down the equation of constraints in Cartesian coordinates. **4**
1) Rigid body 2) Simple pendulum

f) Deduce Hamilton's Principle from D' Alembert's principle? **8**

2. Either

a) i) Define generalized momentum and cyclic coordinates. **2**

ii) Show that the generalized momentum corresponding to a cyclic coordinate remain constant. **2**

iii) Prove the law of conservation of momentum for a system of particles. **4**

b) i) What is Hamiltonian function? Explain its physical significance. Prove that Hamiltonian of a conservative system is equal to the total energy of the system. **5**

ii) Describe the Hamiltonian equations for an ideal spring mass arrangement. **3**

OR

e) i) Prove that poison braket of two dynamical variables is invariant under infinitesimal canonical transformation. **4**

ii) And show that the transformation defined by **4**

$q = \sqrt{2P}\sin Q$

$p = \sqrt{2p}\cos Q$ is canonical.

f) Use Hamilton – Jacobi's theory to solve Kepler's problem. **8**

3. Either

a) i) Show that in an elliptical orbit of a planet around the sun, the major axis solely depends on the total energy. **3**

ii) Further prove that the periodic time is an elliptical orbit is **5**

$$T = 2\pi a^{3/2} \Big/ \sqrt{G(M+m)}$$

Where a is the semi major axis and M the mass of the sun and m that of the planet.

b) Use Hamilton's equation to find the differential equation for planetary motion and prove that the areal velocity is constant. **8**

OR

e) Define scattering cross-section and find the expression of Rutherford's scattering cross-section. **8**

f) Show that for any repulsive central force a formal solution for the angle of scattering can be expressed as **8**

$$\phi = \pi + \int_0^{u_0} \frac{p\,du}{\sqrt{1 - \frac{V}{E} - p^2u^2}}$$

Where V is the potential every $u = 1/r$ and u_0 corresponds to the turning point of the orbit.

4. Either

a) Define Angular momentum of a rigid body and find its expression in terms of moments of Inertia and product of Inertia. **8**

b) Show that the kinetic energy of a rotating rigid body in a coordinate system of principal axes is given by **8**

$$T = y_2\left(I_1W_1^2 + I_2W_2^2 + I_3W_3^2\right)$$

OR

e) What are Euler's Angles? Find the matrix of transformation and its inverse matrix. **8**

f) Consider a rectangular cube of density ρ and mass M and side a for origin O at one corner and axes along of the edges of the cube, determine the inertial tensor. **8**

5. Answer all the following.

a) What type of difficulties arise due to the constraints in the solution of mechanical problems and how these are removed. **4**

b) Prove that Poisson bracket of two constant of motion is itself a constant of motion. **4**

c) Explain and prove total energy of a particle under the action of central force is constant. **4**

d) Using conditions of principal moments of Inertia define spherical top, symmetric top. and asymmetric top. **4**

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