SEMESTER EXAMINATION-2021
CLASS-M.Sc.
SUBJECT: PHYSICS
PAPER CODE: MPH-C102
PAPER TITLE: CLASSICAL MECHANICS

Time: 3 hour **Max. Marks: 70**
Min. Pass: 40%

Note: Question Paper is divided into two sections: **A and B.** Attempt both the sections as per given instructions.

SECTION-A (SHORT ANSWER TYPE QUESTIONS)

Instructions: Answer any five questions in about 150 words each. Each question carries six marks. (5 X 6 = 30 Marks)

Question-1: Express angular momentum of the system as the sum of angular momentum of motion of the centre of mass and angular momentum of the motion about the centre of mass. 6

Question-2: Define generalized co-ordinates and obtain the expression for generalized acceleration and generalized momentum. 6

Question-3: Show that Hamiltonian for the motion of a charged particle in an electromagnetic field is sum of its kinetic energy and electrostatic potential energy. 6

Question-4: a) To show that if a given coordinate is cyclic in Lagrangian, it will also be cyclic in Hamiltonian. 3

b) To show that Lagrangian does not depend on time explicitly, Hamiltonian is constant of motion. 3

Question-5: Obtain the solution of simple harmonic oscillator with the help of canonical transformation. 6

Question-6: Show that the transformation defined by

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

$p = \sqrt{[2P]}\ \cos Q$ is canonical. 6

Question-7: For any central force obtain Laplace-Runge-Lenz vector and explain its

physical significance. 6

Question-8: Show that during the motion under central force, the energy, the angular momentum and the areal velocity remain conserved. 6

Question-9: Obtain Euler's equation of motion for a rotating rigid body. 6

Question-10: Differentiate between stable and unstable equilibrium. 6

SECTION-B (LONG ANSWER TYPE QUESTIONS)

Instructions: Answer any FOUR questions in detail. Each question carries 10 marks. (4 X 10 = 40 Marks)

Question-11: A mass 2m is suspended from a fixed support by a spring, of spring constant, 2k. From this mass, another mass, m, is suspended by another spring constant, k. Find equation of motion of the coupled system. 10

Question-12: a) Explain the principle of virtual work and D'Alembert's principle. 4

b) Derive Lagrange's equations of motion from D'Alembert's principle. 6

Question-13: Derive Hamiltonian equation of motion in spherical coordinates. 10

Question-14: Define Poisson bracket of two dynamical variables. Show that for any three dynamical variables, u, v, w the Jacobi Identity.
[u, [v, w]] + [v, [w, u]] + [w, [u, v]] = 0 is satisfied. 10

Question-15: Determine the canonical transformation defined by generating function

$$F_1 = (q, Q, t) = \frac{1}{2} m\omega(t) q^2 cotQ$$

Find also the new Hamiltonian, K. 10

Question-16: A particle describes a circular orbit given by r= 2a cos$\boldsymbol{\theta}$ under the influence of an attractive central force directed towards a point on the circle. Show that the force varies as the inverse fifth power of the distance. 10

Question-17: Explain the motion of linear tri-atomic molecule to obtain the expressions of normal frequencies and Eigen vectors and sketch the different modes of vibration of three constituent atoms. 10

Question-18: Illustrate with diagrams Euler's angles involved in the transformation from one set of three dimensional coordinate system to another having the same origin. Obtain the complete transformation matrix for such a transformation. Prove that the resultant transformation A = BCD is an orthogonal transformation. 10

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