M.Sc. Examination, 2018

Semester-I

Physics (Core)

Course: MPC-12

(Classical Mechanics-I)

Time: Three Hours **Full Marks:40**

Questions are of value as indicated in the margin

*Answer any **four** of the following.*

1. a) Explain D'Alembert's principle. Use this principle to obtain Lagrange's equation for a many particle system. 1+4

   b) Consider the motion of a charged particle of mass m in a magnetic field. Obtain the Hamiltonian of the system and hence show that the force acting on the particle follows Lorentz force law. 1+4

2. a) Show that $\sum_{l=1}^{l=2n} \{u_l, u_j\}[u_l, u_j] = \delta_{ij}$ (symbols have their usual meanings). 7

   b) What are fundamental Poisson brackets? Show that $[L_x, L_y] = L_z$. 1+2

3. a) Show that $\frac{\delta}{\delta q_i}[u, v] = \left[\frac{\delta u}{\delta q_i}, v\right] + \left[u, \frac{\delta v}{\delta q_i}\right]$. 3

   b) Prove that $[F, G]_{Q, P} = [F, G]_{q, p}$ (symbols have their usual meanings). 7

4. a) What is perihelion precession of Mercury? Show that the perihelion anomaly of mercury equals to $6\pi\mu^2 m^2 / I^2$ where m is the mass of mercury, I, the angular momentum and μ, a constant. 1+6

   b) Show that for a central potential $V(r) = -\frac{k}{r}e^{-r/a}$ (a is constant), bound orbit exists if

   $$r < \frac{a\left(1+\sqrt{5}\right)}{2}$$ 3

5. Consider the elastic collision of two particles of mass m_1 and m_2 respectively in L-frame.

   a) Obtain a relationship between the angle of scattering in L-Frame and C-frame. 6

   b) If $m_1 = m_2$, show that the two particles move at right angles to each other after collision in L-frame. 4

6. a) Show that for a rigid body in motion, $v = V + \Omega \times r$ (symbols have their usual meanings). 3

   b) Find the condition for which a symmetrical top executes a steady precession at a constant inclination angle and hence obtain the fast and slow precessional angular velocity of the top. 5+2

P.T.O.

7. a) Show that for system executing small oscillations about the equilibrium, the equation of motion can be put in the form: $T_{ij}\ddot{\eta}_j + V_{ij}\eta_j = 0$ where T_{ij} and V_{ij} are kinetic and potential energy matrices, and η's are generalized coordinates. 5

   b) A particle of mass *m* executing a small oscillation under a potential $V(x) = A\cos\alpha x - kx$ (*A*, α and *k* are constants). Obtain the frequency and equation of motion of the particle. 3+2

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