LOYOLA COLLEGE (AUTONOMOUS) CHENNAI – 600 034



Date: 11-07-2025

M.Sc. DEGREE EXAMINATION - MATHEMATICS

FOURTH SEMESTER - JULY 2025

Dept. No.



Max.: 100 Marks

PMT4MC03 - CLASSICAL MECHANICS

Time: 10:00 AM - 01:00 PM		
	SECTION A – K1 (CO1)	
	Answer ALL the questions $(5 \times 1 = 5)$	
1	Answer the following	
a)	Define torque.	
b)	What is the purpose of Eulerian angles?	
c)	Define ignorable coordinates.	
d)	When a canonical transformation is said to be infinitesimal contact transformation?	
e)	What are the two types of periodic motion in a dynamical system?	
	SECTION A – K2 (CO1)	
	Answer ALL the questions $(5 \times 1 = 5)$	
2	MCQ	
a)	The equation of motion of a simple pendulum hangs from the ceiling of an elevator which is moving	
	down with a constant acceleration f is	
	$(i) \ddot{\theta} + \frac{(f-g)}{l} \sin\theta = 0 \qquad (ii) \ddot{\theta} + \frac{(f-g)}{l} \cos\theta = 0$	
	(iii) $\ddot{\theta} + \frac{(g-f)}{l}sin\theta = 0$ (iv) $\ddot{\theta} + \frac{(g-f)}{l}cos\theta = 0$	
b)	The configuration of the rigid body would be completely specified by degrees of freedom.	
	(i) 1 (ii) 6 (iii) 9 (iv) 3	
c)	The principle of least action in terms of the arc length of the particle trajectory is given by	
	(i) $\Delta \int \sqrt{2m} \sqrt{(H-V)} ds = 0$ (ii) $\Delta \int \sqrt{m} \sqrt{(H+V)} ds = 0$	
	(iii) $\Delta \int \sqrt{2m} \sqrt{(H+V)} ds = 0$ (iv) $\Delta \int \sqrt{m} \sqrt{(H-V)} ds = 0$	
d)	The equations of motion in Poisson's bracket is	
	$(i) [p_j, H] = p_j; [q_j, H] = q_j $ $(ii) [p_j, H] = -q_j; [q_j, H] = -p_j$	
	(iii) $[p_j, H] = -\dot{p}_j$; $[q_j, H] = \dot{q}_j$ (iv) $[p_j, H] = \dot{q}_j$; $[q_j, H] = \dot{p}_j$	
e)	In a harmonic oscillator, the motion of a particle can be represented as a	
	(i) rotation (ii) wave (iii) oscillation (iv) straight line	

SECTION B – K3 (CO2)	
	Answer any THREE of the following $(3 \times 10 = 30)$
3	Derive Hamilton's principle from D'Alembert's principle.
4	Define angular momentum and derive an expression for the rotational kinetic energy in terms of angular momentum.
5	Write a brief note on Routh's procedure.
6	Justify that the Poisson bracket is invariant under canonical transformation with a suitable proof.
7	Prove that the Hamilton's principle function is given by $S = \int L dt + C$ where L is the Lagrangian.
SECTION C – K4 (CO3)	
	Answer any TWO of the following $(2 \times 12.5 = 25)$
8	Write a brief note on constraints and its classification in a dynamical system.
9	State and prove Euler's theorem.
10	If the component of the applied torque along the axis of rotation vanishes then prove that the
	component of total angular momentum along the axis of rotation is conserved.
11	Derive the Angular momentum - Poisson bracket relation.
SECTION D – K5 (CO4)	
	Answer any ONE of the following $(1 \times 15 = 15)$
12	State and prove the principle of least action.
13	Determine the moments of inertia of a uniform hemisphere about its axis of symmetry and about an
	axis lying in the base perpendicular to the symmetry axis.
SECTION E – K6 (CO5)	
	Answer any ONE of the following $(1 \times 20 = 20)$
14	(a) Derive the Lagrange's equation of motion for a holonomic system. (10 marks)
	(b) Find the action-angle variable for Simple Harmonic Oscillator. (10 marks)
15	State and prove the different possibilities for the generating function in canonical transformation.