

U.G. 5th Semester Examination - 2021

PHYSICS

Course Code : BPHSDSHT2 [DSE2]

Course Title : Classical Dynamics

Full Marks : 40

Time : 2 Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

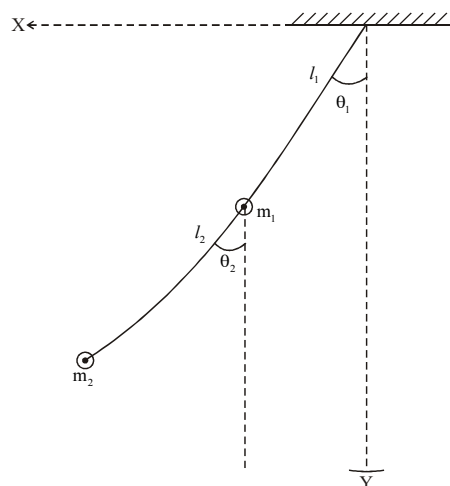
1. Answer any **ten** questions: 1×10=10
- Define Poisson bracket.
 - Write down the differences between streamline motion and turbulent motion.
 - The half life of a particle as measured in the laboratory is 4.0×10^{-8} sec when its speed is $0.80c$ and 3×10^{-8} sec when its speed is $0.60c$. Find its actual half life.
 - Write down the equations which shows how space and time transform in Lorentz transformation.

- The potential energy of a particle is given by $V(x) = x^4 - 3x^3 - 8x^2 + 48x$. Find the points of stable and unstable equilibria.
 - What are normal co-ordinates of a coupled system?
 - What do you mean by gyro-frequency?
 - What do you mean by coefficient of restitution?
 - What is constraint of motion?
 - What are normal modes of oscillations?
 - What is Coriolis force?
 - Define generalised force for a conservative system.
 - What is Routhian?
 - What do you mean by light-like interval?
 - What do you mean by eigenvectors and eigenfrequencies?
2. Answer any **five** questions: 2×5=10
- Starting from the Lagrangian of a linear harmonic oscillator Derive its Hamiltonian.
 - Define Laplace-Runge-Lenz vector.

- c) What will be the period of a "second" pendulum measured by an observer moving with a speed of $0.8c$?
- d) How does the continuity equation change for incompressible fluids? why?
- e) Discuss the limitations of Newtonian mechanics.
- f) How Hamiltonian mechanics related with quantum mechanics?
- g) Show graphically the variation of relativistic mass with velocity of a particle.
- h) What do you mean by stable and unstable equilibrium?

3. Answer any **two** questions: 5×2=10

- a) Consider a double pendulum system as shown in the figure.



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[Turn Over]

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- i) How many generalized co-ordinates are required to describe the motion of this system?
- ii) Write down its Lagrangian.
- iii) Hence arrive at the equation of motion.

1+2+2

- b) Establish the relation $E^2 = p^2c^2 + m_0^2c^4$, the symbols have their usual meanings. A body of mass m disintegrates into two parts of masses m_1 and m_2 while at rest. Show that the energies E_1 and E_2 of the two pieces satisfy the relation

$$\frac{E_1}{E_2} = \frac{m^2 + m_1^2 - m_2^2}{m^2 + m_2^2 - m_1^2} \quad 2+3$$

- c) Discuss the principle of least action. Given the following Lagrangian for an anharmonic oscillator, find its corresponding Hamiltonian.

$$L(x, \dot{x}) = \frac{1}{2}\dot{x}^2 - \frac{1}{2}\omega^2x^2 - \alpha x^3 + \beta x\dot{x}^2, \quad \text{where}$$

α, β and ω are constants. 3+2

4. Answer any **one** question: 10×1=10

- a) i) Using continuity equation, Euler equation and the first law of thermodynamics, derive conservation laws for the momentum and energy of an ideal fluid. 5

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- ii) Deduce the amount of pressure inside a water droplet. Write your answer in terms of radius of droplet and the surface tension of water at that particular temperature. 5
- b) i) What are central forces?
Show that:
A) Central force is conservative in nature.
B) While moving in a central force, the particle's angular momentum is conserved.
C) The particle moves in a plane.
1+3+3+3
- c) i) The point of suspension of a simple pendulum moves harmonically along the vertical upward direction. Discuss the motion by Hamiltonian method.
- ii) A double pendulum consists of a mass m_1 and length L_1 to which a second pendulum of mass m_2 and length L_2 is suspended. Discuss its small oscillations in a vertical plane. 5+5
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