A-0586

Total Pages : 4 **Roll No. .....**

MSCPH–502

M.Sc. PHYSICS (MSCPH)

(Classical Mechanics)

1st Semester Examination, Session December 2024

Time : 2:00 Hrs. Max. Marks : 70

Note* :–** This paper is of Seventy (70) marks divided into Two (02) Sections 'A' and 'B'. Attempt the questions contained in these Sections according to the detailed instructions given therein. ***Candidates should limit their answers to the questions on the given answer sheet. No additional (B) answer sheet will be issued.

Section–A

Long Answer Type Questions 2×19=38

***Note* :–** Section 'A' contains Five (05) Long-answer type questions of Nineteen (19) marks each. Learners are required to answer any *two* (02) questions only.

1. What do you understand by cyclic coordinate ? The Lagrangian for a system is :

$$L = \frac{1}{2} m(\dot{r}^2 + r^2\dot{\theta}^2 - v(v)$$

Identify the cyclic corrdinates and the corresponding conservation law for the problem and also prove that the generalised momentum conjugate to a cyclic coordinate is conserved,

2. Derive Hamilton's canonical equation of motion. What is the physical significance of Hamiltonian function ? Obtain the Hamilton's equation of a charged particle in an electromagnetic field.

3. State and derive principle of Least Action. Obtain the Jacobi's form of Least Action principle.

4. Two identical harmonic oscillators are coupled together. Establish the equation of motion and obtain the general solutions. Also describe the two normal modes.

5. Write short notes on any *two* of the following

   (a) Canonical transformation and generating functions

   (b) Lagrange and Poisson brackets

   (c) Angular momentum and inertia tensor

Section–B

Short Answer Type Questions 4×8=32

***Note* :–** Section 'B' contains Eight (08) Short-answer type questions of Eight (08) marks each. Learners are required to answer any *four* (04) questions only.

1. Explain the principle of virtual work. Hence deduce D'Alembert's principle.

2. Set up the Lagrangian and obtain the Lagrange's equation for a simple pendulum. Also deduce the formula for its time period.

3. A particle of mass m is attracted towards a given point by a force of the form $\frac{k}{r^2}$, Where k is a constant. Write down the expression for the Hamiltonian of the system and derive Hamilton's equation of motion.

4. Derive equation of motion for a harmonic oscillator using Hamiltonian Formulation.

5. If any function is constant of motion, show that its Poisson-Bracket with Hamiltonian H vanishes.

6. Show that the the transformation :

$$P = q \cot p \quad \text{and} \quad Q = \log\left(\frac{\sin p}{q}\right)$$

is canonical. Show that generating function is :

$$F = e^{-Q}(1 - q^2 e^{2Q})^{1/2} + q \sin^{-1}(qe^{Q})$$

7. Discuss Rutherford alpha scattering in Coulomb's field.

8. Discuss the motion of a rigid body under central force. Also comment which conservation law it leads from its Lagrangian/first integrals.

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