D 114597 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2024

(CBCSS)

Physics

PHY1C01—CLASSICAL MECHANICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

Answer **all** *questions.*
Each question carries 1 weightage.
8 short questions answerable within 7½ minutes

1. What are the constraints of a rigid body ?
2. Explain Legendre transformation
3. What are coupled oscillators ?
4. How much is the number of degrees of freedom for a) Four particles moving freely in space ; b) A rigid body with two points fixed ?
5. Define phase space.
6. Differentiate between forced and free vibrations.
7. State Canonical or Contact transformation.
8. Define Jacobi identity.

(8 × 1 = 8 weightage)

Section B

Answer any **two** *questions.*
Each question carries 5 weightage.
4 essay questions answerable within 30 minutes

9. Derive Lagrange's equation from Hamilton's principle
10. Obtain the equation of motion of two masses connected by a string and passes through a smooth pulley by using Lagrange equation.
11. Define Poisson bracket and discuss any four their properties with proof.
12. Explain normal modes of vibrations.

(2 × 5 = 10 weightage)

Turn over

Section C

Answer any **four** *questions.*
Each question carries 3 weightage.
7 problems within 15 minutes.

13. Calculate the reduced mass of the following : a) Hydrogen atom b) positronium . Show that reduced mass of Hydrogen atom is almost half of positronium.

14. Solve Kepler's problem by using H-J method.

15. Show that Poisons brackets are a) commutative b) distributive.

16. Write the Lagrange's equation of motion of a particle moving under gravity of mass m near the surface of earth.

17. Show that the transformation is canonical.

    a) $P = 1/2 (p^2 + q^2)^2$.

    b) $Q = \tan^{-}(q/p)$.

18. Show that Poisson brackets are invariant under canonical transformations.

19. Prove that two or more successive canonical transformations also is canonical.

(4 × 3 = 12 weightage)

D 52837 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2023

(CBCSS)

Physics

PHY IC 01—CLASSICAL MECHANICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

Answer **all** *questions. Each question carries* 1 *weightage.*
8 *short questions answerable within* 7.5 *minutes.*

1. Write a note on holonomic and non-holonomic constraints.
2. What are the generalised co-ordinates of simple pendulum.
3. What is meant by reduced mass ?
4. Poisson brackets are commutative ; Prove.
5. Define logistic map.
6. Write down any *two* conditions for a transformation to be canonical.
7. What are coupled oscillators ?
8. Define Hamilton Principal function.

(8 × 1 = 8 weightage)

Section B

Answer any **two** *questions.*
Each question carries 5 *weightage.*
Essay questions answerable within 30 *minutes.*

9. Using Lagrange equation find the equation of motion of compound pendulum.
10. Reduce two body central force problem into an equivalent single body problem.

Turn over

11. Write a note on symmetry properties of space and time and conservation laws.

12. What do you understand by normal modes of vibrations ?

(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions.*
Each question carries 3 *weightage.*
problems within 15 *minutes.*

13. Write the Lagrange's equation of motion of a particle moving under gravity of mass m near the surface of earth.

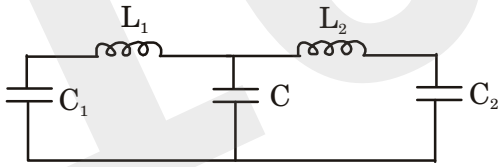
14. Solve Harmonic oscillator problem by using H-J method.

15. A particle of mass m moving in a plane in the field of a force is given by $F = -kr\cos\theta$.

    a) Justify whether the angular momentum is conserved.

    b) Obtain the differential equation of the orbit of the particle.

16. Find the Lagrangian of the circuit shown. Find the normal frequencies of the system.



17. Discuss the conditions for canonical transformation .

18. Show that $[F,(G+K)]=[F,G]+[F,K]$.

19. Explain the term chaos.

(4 × 3 = 12 weightage)

D 32730 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. (CBCSS) REGULAR/SUPPLEMENTARY DEGREE EXAMINATION, NOVEMBER 2022

Physics

PHY1C01—CLASSICAL MECHANICS

(2019 Admission onwards)

Time : Three Hours Maximum Weightage : 30

Section A

Answer all questions.Each question carries 1 *weightage.*
8 short questions answerable within 7.5 minutes

1. What are generalized co-ordinates ?
2. Evaluate the Poisson bracket $\left[J_x, P_y\right]$.
3. Define inertia tensor.
4. Discuss the significance of normal co-ordinates and normal modes of vibrations.
5. Give an example for nonlinear oscillations. Describe the conditions under which those oscillations turn into chaotic.
6. What is Legendre Transformation ? Explain how Hamiltonian of a system can be obtained from Lagrangian.
7. What are cyclic co-ordinates ? How are they related to conservation laws ?
8. What is the physical significance of Hamilton's characteristic functions ?

(8 × 1 = 8 weightage)

Section B

Answer any **two** *questions.Each question carries* 5 *weightage.*
4 essay questions answerable within 30 minutes

9. Obtain Lagrange's equation from Hamilton's principle.
10. Discuss linear Harmonic oscillator problem using Hamilton-Jacobi theory.
11. Discuss the case of logistic map, find the fixed points and describe the onset of chaos through period doubling.
12. Discuss the rigid body motion in terms of direction cosines and Euler angles, Infinitesimal rotation.

(2 × 5 = 10 weightage)

Turn over

Section C

Answer any **four** *questions.Each question carries* 3 *weightage*
7 problems within 15 minutes

13. A simple pendulum has a bob of mass m with a mass m_1 at the moving support (pendulum with moving support) which moves on a horizontal line in the vertical plane in which the pendulum oscillates. Find the Lagrangian and Lagrange's equation of motion.
14. Discuss the motion of a disc of mass m and radius b rolling down an inclined plane without sliping. Also, find the force of constraint using the Lagrange method of undetermined multipliers.
15. Consider scattering of particles by a rigid sphere of radius R and calculate the differential and total cross-sections.
16. Find the canonical transformation generated by the generating function $F_1 = q_i Q_i$.
17. Find the possible fixed points of a damped pendulum with damping force proportional to velocity. Discuss their stability.
18. Find the maximum values possible for the centrifugal force acting on a body of mass m = 20 kg. due to the spin of the earth as the equator given that the radius of the earth is R = 6400 km.
19. Obtain Hamilton's equations for a particle of mass m moving in a plane about a fixed point by an inverse square force. Hence, obtain the radial equation of motion.

(4 × 3 = 12 weightage)

D 13157 **(Pages : 2)** **Name.....**

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021

(CBCSS)

Physics

PHYIC01—CLASSICAL MECHANICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

(8 Short questions answerable within 7.5 minutes)

Answer **all** *questions.*
Each carries weightage 1.

1. State d' Alembert's principle.
2. Define Poisson bracket of two variables and discuss its important properties.
3. Distinguish between Centrifugal and Coriolis forces
4. Define normal frequency and discuss its significance.
5. What are limit cycles ? Distinguish between stable limit cycle and semistable limit cycle.
6. What is chaos ? How does it arise ?
7. Explain different types of constraints.
8. What are canonical transformations ? What is the use of using canonical transformation?

(8 × 1 = 8 weightage)

Turn over

Section B

(4 essay questions answerable within 30 minutes)

Answer any **two** *questions.*
Each carry weightage 5.

9. Explain bow action angle variables can be used to find frequencies of periodic motion in Kepler problem.
10. Discuss the precisional motion-with and without rotation of a spinning top under gravity.
11. Find the frequencies of free vibrations of a linear triatomic symmetric molecule.
12. Discuss Pitch Forck bifurcation, period of doubling and fixed points with respect to logistic Map.

(2 × 5 = 10 weightage)

Section C

(7 problems answerable within 15 minutes)

Answer any **four** *questions.*
Each carry Weightage 3.

13. In the absence of external torque on a body, prove that : (i) The kinetic energy is constant ; and (ii) The magnitude of the square of the angular momentum (L 2) is constant.
14. A bead of mass m slides freely on a frictionless circular wire of radius a that rotates in a horizontal plane about a point on the circular wire with a constant angular velocity ω. Find the equation of motion of the bead by Lagrange's method. Also show that the bead oscillates as a pendulum of length = $\frac{g}{\omega^2}$.
15. Using Lagrange's method of undetermined multiplier, find the equation of motion and force of constraint in the case of a simple pendulum.
16. Using the Poisson bracket, show that the transformation $q = \sqrt{2P}\sin Q$, $p = \sqrt{2P}\cos Q$ is canonical.
17. Find Lagrange's equation of motion of the bob of a simple pendulum.
18. Obtain the Hamiltonian of a charged particle in an electromagnetic field.
19. Show that the transformation $p = m\omega q \cot Q$ and $P = \frac{m\omega q^2}{2\sin^2 Q}$ is canonical. Also obtain the generating function for the transformation.

(4 × 3 = 12 weightage)

D 93432 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY IC 01—CLASSICAL MECHANICS

(2019 Admissions)

Time : Three Hours Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

Section A

8 short questions answerable within 7½ minutes.

Answer **all** *questions, Each carry weightage* 1.

1. State the principle of least action.
2. Explain how action angle variables can be used to obtain the frequency of periodic motion.
3. What do you mean by precession and nutation ?
4. Briefly explain stable and unstable equilibrium.
5. Explain the concept of Universality.
6. Describe the fixed point using suitable example.
7. State and explain Hamilton's principle.
8. Give the relation between Lagrangian bracket and Poisson bracket.

(8 × 1 = 8 weightage)

Turn over

Section B

4 Short questions answerable within 30 minutes.
Answer any **two** *questions, Each carry weightage 5.*

9. Obtain Lagrange's equation from d'Alembert's principle. Give examples of generalized co-ordinates.
10. Discuss the general theory of small oscillations and deduce eigenvalue equation.
11. Show that Poisson brackets are invarients under canonical transformations. Also, express equation of motion in Poisson bracket form.
12. Differentiate between linear and non-linear systems. Explain the period doubling route to chaos with a suitable example

(2 × 5 = 10 weightage)

Section C

7 problems answerable within 15 minutes.
Answer any **four** *questions, each carry weightage 3.*

13. Masses m and $2m$ are connected by a light inextensible string which passes over a pulley of mass $2m$ and radius α. Write the Lagrangian and find the acceleration of the system.
14. Show that the shortest distance between two points is a straight line.
15. Obtain Hamilton's equations for a simple pendulum. Hence, obtain an expression for its period.
16. Find the Poisson bracket of [Lx, Ly], where Lx and Ly are angular momentum components.
17. Find the moments and products of inertia of a homogeneous cube of side a for an origin at one corner, with axes directed along the edges.
18. Find the normal frequencies and normal modes for a double pendulum, each having a mass m suspended by a string of length l.
19. Show that the following transformation is canonical. $Q = \sqrt{2qe}^{\alpha} \cos p$, $P = \sqrt{2qe}^{-\alpha} \sin p$, α is constant.

(4 × 3 = 12 weightage)

D 72978 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.A./M.Sc./M.Com. DEGREE EXAMINATION DECEMBER 2019

(CBCSS)

Physics

PHY 1C 01—CLASSICAL MECHANICS

(2019 Admissions)

Time : Three Hours Maximum : 30 Weightage

Section A

Answer **all** *questions, each carry weightage* 1.

1. State d'Alembert's principle.
2. Show that the transformation ; (q, p) to (Q, P) defined by $Q = -p$, $P = q$ is an example of canonical transformation.
3. Show that Schrödinger equation reduces to Hamilton-Jacobi equation in the appropriate limit.
4. Find the Hamiltonian corresponding to the Lagrangian,

$$L = \frac{1}{2} m\dot{q}^2 - c\dot{q}$$

where c is a constant.

5. What is meant by Coriolis force ?
6. What do you mean by precession and nutation ?
7. What are generalised co-ordinates ?
8. Explain the concept of universality.

(8 × 1 = 8 weightage)

Section B

Answer any **two** *questions, each carry weightage* 5.

9. Explain Hamilton's principle and use that to derive the Lagrange's equations.
10. Explain the concept of action-angle variables with an example.
11. Find the frequencies of free-vibrations of a linear triatomic symmetric molecule.

Turn over

12. Discuss the case of logistic map, find the fixed points and describe the onset of chaos through period doubling.

(2 × 5 = 10 weightage)

Section C

Answer any **four** *questions, each carry weightage* 3.

13. Taking the case of a simple harmonic oscillator in one dimension show how do we obtain the Hamiltonian from the Lagrangian.

14. By calculating the Poisson bracket show that the following transformation is a canonical transformation :

$$Q = \tan^{-1}\left(mw\frac{q}{p}\right), P = \frac{1}{w}\left(\frac{p^2}{2m} + \frac{1}{2}mw^2q^2\right).$$

15. Find the generating function for the infinitesimal transformation;

$$Q = q + c, P = p.$$

16. Solve the harmonic oscillator problem via the Hamiltonian formulation.

17. Prove the Poisson bracket relation between angular momentum components given by

$$[L_x, L_y] = L_z.$$

18. Show that the definition of moment of inertia as :

$$I = \sum_i m_i (\vec{r}_i \times \vec{n}) \cdot (\vec{r}_i \times \vec{n})$$

reduces to

$$I = \sum_i m_i \left(\vec{r}_i^{\,2} = \cdot \left(\vec{r}_i \cdot \vec{n}\right)^2\right).$$

19. Find the maximum values possible for the centrifugal force acting on a body of mass m = 20 kg. due to the spin of the Earth as the equator, given that the radius of the Earth is R = 6400 km.

(4 × 3 = 12 weightage)

D 51452 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2018

(CUCSS–PG)

Physics

PHY 1C 01—CLASSICAL MECHANICS

(2017 Syllabus Year)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions.*
Each carries weightage 1.

1. What is principle of virtual work and D' Alembert's principle ?
2. Describe Hamilton's Canonical equations.
3. Discuss the Lagrange's equations of motion in the presence of generalized potentials.
4. Suggest a generating function which generates the identity transformation. Explain.
5. Briefly explain Canonical Transformation.
6. Describe the significance of action -angle variables.
7. Derive the equation for Coriolis force. What is its effect on projective shot on earth ?
8. Describe Euler angles with respect to rotation of rigid body.
9. Discuss the significance of normal co-ordinates and normal modes of vibrations.
10. What do you mean by symmetric and unsymmetric modes in a two coupled oscillator ?
11. Give examples for nonlinear oscillations. Describe conditions under which those oscillations turn into chaotic.
12. Describe the universality of chaotic systems.

(12 × 1 = 12 weightage)

Section B

Answer any **two** *questions.*
Each carries weightage 6.

13. Discuss scattering in a central force field. Derive Rutherford expression for differential scattering cross section.
14. Discuss the properties of Poisson Brackets. Show that Poisson Brackets are invariant under canonical transformation.

Turn over

15. Discuss and obtain the Lagrange's equation of motion for small oscillations.

16. Describe the Logistic Map. Discuss fixed points, universal constants and bifurcation diagram for it.

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*
Each carries weightage 3.

17. Find the shortest distance between any two points by the method of calculus of variations.

18. Prove that the transformation $q = \sqrt{\frac{2p}{k}} \sin Q$ and $p = \sqrt{2pk} \cos Q$ is canonical and hence obtain the generating function.

19. Four mass points each of mass m are placed at $(a, 0, 0)$, $(0, a, 0)$, $(0, 0, a)$ and (a, a, a). Evaluate the inertia tensor of the system.

20. Describe infinitesimal rotations of rigid body.

21. Describe the possible attractors for pendulum motion under various conditions.

22. Derive the expressions for normal frequencies and for normal co-ordinates for the vibrations of linear tri atomic molecule.

(4 × 3 = 12 weightage)

D 51448 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2018

(CUCSS—PG)

Physics

PHY 1C 01—CLASSICAL MECHANICS

(2012 Syllabus Year)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. Explain the concept of generalized co-ordinate and generalized velocity.
2. What is centre of mass ? Show that in the absence of external force the velocity of the centre of mass remain constant.
3. What are Hamilton's canonical equations of motion ?
4. If a co-ordinate 'q' is cyclic in Lagrangian formalism is also cyclic in Hamilton's formalism, Explain.
5. What is canonical transformation ?
6. Explain the physical significance of Hamilton's principle function.
7. What are ignorable co-ordinates ? Illustrate with example.
8. What is meant by rate of change of a vector ?
9. What are Euler's angles ?
10. Show that the rotational kinetic energy of a rigid body can be represented as $T = 1/2\ \vec{w} . L$
11. What do you understand by normal modes of vibrations ?
12. Write a note on fractals.

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries 6 *weightage.*

1. Obtain the Lagrangian for a charged particle moving in an electromagnetic field.
2. What are action and angle variables. Obtain the solution of a Harmonic oscillator problem using action-angle variable method.

Turn over

3. What are normal modes of vibration ? Discuss the Longitudinal vibration of Linear triatomic molecule.

4. What is periodic doubling in chaos ? Explain the formation of a chaotic system using a Logistic equation.

(2 × 6 = 12 weightage)

Part C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

1. A particle is constrained to move in a circle in the vertical plane xy . Using D'Alembert's principle show that for equilibrium $\ddot{x}\, y - \ddot{y}\, x - gx = 0$.

2. Show the equivalence of Lagrange's and Newton's equation.

3. For the Lagrangian $L = \frac{1}{2} m (\dot{x}^2 + \dot{y}^2 + \dot{z}^2) + \frac{\omega}{2} L_z$ where L_z is the 'z' component of angular momentum. Obtain the Hamiltonian.

4. A particle of mass m moves along the x axis under the influence potential energy $V(x) = -k\, x \exp(-\beta\, x)$ where k and β are constants. Find the equilibrium position.

5. Show that the following transformations are canonical $Q = 1/p$ $P = qp^2$

6. Find the frequency of a linear harmonic oscillator using action angle variables. Write Hamilton's equation of motion.

(4 × 3 = 12 weightage)

D 13193 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2016

(CUCSS)

Physics

PHY 1C 01—CLASSICAL MECHANICS

(2012 Admissions)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries 1.

1. Prove that the total angular momentum about a point 'O' of a system of particles is the angular momentum of the system concentrate at the centre of mass plus the angular momentum of the motion about the centre of mass.
2. State and prove work energy theorem. What are conservative forces ?
3. Set up the Lagrangian and obtain the Lagrange's equation of motion for a simple pendulum.
4. Differentiate between scattering angles in laboratory and centre of mass co-ordinate.
5. Explain Hamilton's modified principle.
6. Define Poisson brackets and explain its important properties.
7. Explain the physical significance of Hamilton's characteristic function.
8. Explain how action-angle variable provides a way to quantization of a system.
9. What do you understand by the inertia tensor of a rigid body ?
10. Explain Coriolis forces.
11. Briefly explain stable and unstable equilibrium.
12. Define fixed point of a chaotic system. Give examples.

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries 6.

1. Explain different symmetry properties and its relation to different conservation laws.
2. Deduce Hamilton's equations of motion and explain canonical transformation and obtain equations of transformation using generating functions F (q, P, t) and F (p, P, t).
3. Discussed the Euler's angles as the generalized co-ordinate for a rigid body motion, obtain an expression for the angular velocity of a rigid body motion in Euler's angle.
4. Discuss Logistic equation and explain Feigenbaum plot for a range of values of control parameter.

(2 × 6 = 12 weightage)

Turn over

Part C

Answer any **four** *questions.*
Each question carries 3.

1. A ball rolls without friction on the inside of a circular annulus. The annulus is put upright in the earth's gravitational field. Obtain equation of motion using D'Alembert's principle.
2. Show that Kinetic energy is a quadratic function of generalized velocity.
3. Lagrangian is given by $L = T - e\phi + \frac{e}{c} A.V$ if A and ϕ are independent of time t. Obtain Hamiltonian.
4. A particle of mass m moves along the x axis under the influence potential energy $V(x) = -k\,x \exp(-\beta x)$ where k and β are constants. Find the equilibrium position.
5. For simple harmonic oscillator $H = \frac{p^2}{2m} + \frac{1}{2} m\omega^2 q^2$. The generating function is $F_1 = \frac{1}{2} m\omega q^2 \cot Q$. Obtain canonical transformation.
6. The motion of a particle of mass m is described by the Hamiltonian $H = p_1^2/2m + p_2^2/2m + m\,Aq_1$ where A is a constant. Obtain the solution of the equation of motion using Poisson brackets.

(4 × 3 = 12 weightage)

D 92955 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2015

(CUCSS)

PHY 1C 01—CLASSICAL MECHANICS

(2012 Admission onwards)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. Is the Lagrangian formulation more advantageous than the Newtonian formulation ? Why ?
2. What is meant by a non-conservative force ? Is the Lorentz force non-conservative ?
3. Explain the principle of least action.
4. Write down the Jacob's form of the least action principle.
5. What is a Coriolis force ? Give example.
6. When is a force field said to be conservative ? Give example.
7. How is a generalized potential defined ? How is it different from the conventional potential ?
8. Can we determine the cross section by using only one projectile particle and one target particle ? Explain.
9. Show that Eigenvectors corresponding to the two distinct Eigenfrequencies are orthogonal.
10. What is Chaos ? How does it arise ?
11. Explain the meaning of a vanishing resonant frequency.
12. What is a logistic map ? Express it Mathematically.

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries 6 *weightage.*

1. Derive the Lagrange's equations of motion from D'Alembert's principle.
2. Derive Euler's equation of motion for rigid bodies. Explain the force free motion of a symmetric top.
3. Obtain the nonlinear equation for a pendulum. Derive the exact solution of the equation in terms of elliptic integral.
4. What is differential Scattering cross section ? Derive the Rutherford formula for scattering cross section in a Central force field Scattering.

(2 × 6 = 12 weightage)

Turn over

Part C

Answer any **four** *questions.*
Each question carries 3 *weightage.*

1. Show that the transformation $Q = \log\left(1 + \sqrt{q}\cos P\right)\sin P$ is canonical.

2. A particle describes a circular orbit given by $r = 2a\cos\theta$ 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.

3. Show that for a single particle with constant mass the equation of motion implies the following differential equation for the kinetic energy. $\frac{dT}{dt} = F.V$ while if the mass varies with time the corresponding equation is $\frac{d(mt)}{dt} = F.P.$

4. Set up the Hamilton Jacobi equation for a freely falling body and find the solution.

5. Calculate the potential due to a thin circular ring of very small radius a and mass m at a point in the plane of the ring but lying outside the ring ($r>>a$).

6. $Q = aq + bP$ and $P = cq + dP$. Prove that the above transformation is canonical only if $ad - bc = 1$.

(4 × 3 = 12 weightage)

D 52980 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, JANUARY 2014

(CUCSS)

Physics

PHY IC 01—CLASSICAL MECHANICS

(2012 admissions)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries a weightage of 1.

1. Is the Lagrangian formulation more advantages than the Newtonian formulation ? Why ?
2. State D' Alembert's principle.
3. Explain the principle of least action.
4. Write down the Jacob's form of the least action principle.
5. Plot the equivalent one dimensional potential for an attractive inverse fourth law of force.
6. When is a force field said to be conservative ? Give example.
7. How is a generalized potential defined ? How is it different from the conventional potential ?
8. What is a non-conservative force ? Is the Lorenz force non-conservative ?
9. Show that Eigen vectors corresponding to the two distinct Eigen frequencies are orthogonal.
10. What is Chaos ? How does it arise ?
11. What are Fractals ? Give an example.
12. What is a logistic map ? Express it mathematically.

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries a weightage of 6.

1. What is differential scattering cross-section ? Derive the Rutherford formula for scattering cross-section in a Central force field scattering.
2. Set up the differential equation of the orbit for planetary motion. Derive the Kepler's laws from the differential equation.

Turn over

3. Obtain the non-linear equation for a pendulum. Derive the exact solution of the equation in terms of elliptic integral.

4. Derive Euler's equation of motion for rigid bodies. Explain the force free motion of a symmetric top.

(2 × 6 = 12 weightage)

Part C

Answer any **four** *questions.*
Each question carries a weightage of 3.

1. Show that the transformation $Q = \sqrt{2q}\, e^{\infty} \cos p$ and $P = \sqrt{2q} e^{-\infty} \sin P$ is a Canonical transformation.

2. A particle describes a circular orbit given by $r = 2a\cos\theta$ 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.

3. Show that for a single particle with constant mass the equation of motion implies the following differential equation for the kinetic energy. $\frac{dT}{dt} = F.V.$ while if the mass varies with time the corresponding equation is $\frac{d(mt)}{dt} = F.P.$

4. For the following Poisson bracket prove that $[a.r., b.p] = a.b.$
$[J,(r.p)] = 0.$

5. Calculate the potential due to a thin circular ring of very small radius a and mass m at a point in the plane of the ring but lying outside the ring ($r > > a$).

6. $Q = aq + bP$ and $P = cq + dP$. Prove that the above transformation is Canonical only if $ad - bc = 1$.

(4 × 3 = 12 weightage)

II-COPY

D 72894 (Pages : 2) Name.....

Reg. No.....

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2014

(CUCSS)

Physics

PHY 1C 01—CLASSICAL MECHANICS

(2012 Admission onwards)

Time : Three Hours Maximum : 36 Weightage

Part A

Answer **all** *questions.*
Each question carries 1 *weightage.*

1. Is the Lagrangian formulation more advantageous than the Newtonian formulation ? Why ?
2. Explain what Kepler's first law implies when it is coupled with the second law ?
3. What is gauge transformation ? What arbitrariness does it introduce ?
4. Write down the Jacob's form of the least action principle.
5. Give the Lagrangian for the Kepler problem.
6. What is linear transformation ? Give example.
7. How is generalized potential defined ? How is it different from the conventional potential ?
8. What is meant by impact parameter ? What is its magnitude for a head on collision ?
9. When does the CM system coincide with the lab system in the case of two body collision ?
10. What is Chaos ? How does it arise ?
11. Define degree of freedom. Give example.
12. Write down the Lagrangian for a dumb bell.

(12 × 1 = 12 weightage)

Part B

Answer any **two** *questions.*
Each question carries 6 *weightage.*

1. What is differential scattering cross section ? Derive the Rutherford formula for scattering cross section in a Central force field scattering.
2. What is meant by action and angle variable ? Discuss the Harmonic oscillator problem using action and angle variable technique.

Turn over

3. Obtain the non-linear equation for a pendulum. Derive the exact solution of the equation in terms of elliptic integral.
4. Derive Euler's equation of motion for rigid bodies. Explain the force free motion of a symmetric top.

(2 × 6 = 12 weightage)

Part C

Answer any **four** *questions. Each question carries 3 weightage.*

1. Show that the transformation $Q = \sqrt{2q}\, e^{\infty} \cos p$ and $P = \sqrt{2q}\, e^{-\infty} \sin P$ is a canonical transformation.
2. Find the horizontal component of the Coriolis force acting on a body of mass. 1.5 kg moving northward with horizontal velocity of 100 m/sec at 30° N latitude on earth.
3. Show that for a single particle with constant mass the equation of motion implies the following differential equation for the kinetic energy. $\frac{dT}{dt} = F.V$ while if the mass varies with time the corresponding equation is $\frac{d(mt)}{dt} = F.P$.
4. For the following Poisson bracket prove that $[a.r, b.p] = a.b$ $[J, (r.p)] = 0$
5. A person in a jet plane is flying along the equator due East with a speed of 540 m/sec. What is his Coriolis acceleration ?
6. $Q = aq + bp$ and $P = cq + dP$. Prove that the above transformation is canonical only if $ad\text{-}bc = 1$.

(4 × 3 = 12 weightage)

C 32344 (Pages : 2) Name.....

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FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2017

(CUCSS)

Physics

PHY 1C 01—CLASSICAL MECHANICS

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions.*

Each question carries weightage 1.

1. Explain the significance of Rayleigh's dissipation function in setting up the equations of motion.
2. State and explain the Hamilton's principle.
3. A Lagrangian is given as $L=\frac{1}{2}m\left(\dot{x}^2-\omega^2x^2\right)e^{\gamma t}$ where the particle of mass m moves in one direction. Find the equations of motion.
4. Give the physical significance of Hamilton's Principal Function and Hamilton's Characteristic Function.
5. Explain angular momentum commutator in Poisson Brackets.
6. Get the relation between Lagrange bracket and Poisson bracket.
7. Describe the direction cosines of the body set of axes relative to space fixed axes.
8. Find the rate of change of a vector with respect to a rigid body.
9. Define normal frequency and discuss its significance.
10. Express kinetic energy and potential energy of a two coupled oscillator in terms of normal co-ordinates.
11. What are Feignbaum number and Lyapunov exponent ?
12. Describe the fixed point in the case of damped oscillator.

(12 × 1 = 12 weightage)

Turn over

Section B

Answer any **two** *questions.*
Each question carries weightage 6.

13. Discuss Hamilton Jacobi Equation and hence solve Harmonic Oscillator problem.

14. What are Euler angles ? Discuss infinitesimal rotations of a rigid body.

15. Discuss the oscillation of a linear triatomic molecule.

16. Discuss Pitch Fork bifurcation, period doubling and fixed points with respect to logistic Map.

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*
Each question carries weightage 3.

17. Show that the generating function F_1 and F_2 can generate exchange and identity transformations respectively.

18. Solve Brachistochrone problem by the method of calculus of variations.

19. Show that the transformation $P = \frac{1}{z}\left(p^2 + q^2\right), Q = \tan^{-1}\frac{q}{p}$ is canonical.

20. Consider a particle falling freely from a height h at latitude a. Find its deflection from the vertical due to Coriolis force.

21. Arrive the phase space diagrams for undamped, damped and forced oscillations.

22. Derive the Lagrang's equation of motion for small oscillations.

(4 × 3 = 12 weightage)