18P106 (Pages: 2) Name: …………………….

Reg. No…………………...

FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2018

(Regular/Supplementary/Improvement)

(CUCSS-PG)

CC15P PHY1 C01 / CC17P PHY1 C01 – CLASSICAL MECHANICS

(Physics)

(2015 Admission onwards)

Time: Three Hours Maximum: 36 Weightage

Section A

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

1. What are constraints? Mention the difficulties introduced by the constraints in the solution of mechanical problems.
2. Discuss the superiority of Lagrangian approach over Newtonian approach.
3. What is a cyclic co-ordinate? Show that generalized momentum conjugate to a cyclic co-ordinate is conserved.
4. Prove that the motion of a particle under central force takes place in a plane.
5. For a conservative system, deduce the equation

$$\Delta \int_{t_1}^{t_2} \sum_k P_k \dot{q}_k dt = 0$$

6. Discuss Legendre Transformations.
7. Define a Poisson Brackets. Derive the relation between Lagrange Brackets and Poisson Brackets.
8. Establish Hamilton Jacobi equation.
9. From the general theory of small oscillations, deduce the equation of motion of a system executing small oscillations.
10. Find the relation between the angular momentum, the inertia sensor & the angular velocity vector.
11. Explain Coriolis forces.
12. Discuss the phase trajectory for the force equation F = kx, where ‘**k**’ is a positive constant.

(12 x 1 = 12 Weightage)

Section B

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

13. What are action - angle variables? How are they used to obtain the frequencies of periodic motion? Determine the frequency of a linear harmonic oscillator using action - angle variables.
14. Discuss in detail, the vibrations of a carbon dioxide (CO_2) molecule.
15. Describe the force free motion of a rigid body.
16. What is a logistic map? Discuss fixed points and their stability. Explain how the bifurcations lead to chaos when the control parameter exceeds 3.57.

(2 x 6 = 12 Weightage)

Section C

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

17. Obtain the Lagrangian for a charged particle moving in an electromagnetic field.
18. A particle of mass ‘m’ moves along the x axis under the influence of potential energy $V(x) = - kx \exp(- \beta x)$, where k and β are constants. Find the equilibrium position.
19. Show that the period of non - linear oscillations of a simple pendulum is

$$\mathbf{T} = \mathbf{To}\left[\mathbf{1} + \frac{\boldsymbol{\theta}_{\mathbf{o}}^{2}}{\mathbf{16}}\right]$$

where $\mathbf{To} = \mathbf{2\pi}\sqrt{\frac{\mathbf{l}}{\mathbf{g}}}$ and θo = amplitude of oscillation

20. The Lagrangian for anharmonic oscillator is given by $L(x, \dot{x}) = \frac{1}{2}\dot{x}^2 - \frac{1}{2}w^2x^2 - \alpha x^3$.

Find the Hamiltonian.

21. Consider a rectangular parallelopiped of uniform density ρ, mass M with sides a, b and c. For the origin at one corner, find the moments and products of inertia of the parallelopiped by taking the co-ordinate axes along the edges. Hence determine the inertia tensor of a cube (a = b = c)
22. Show that the given transformation is canonical

$$q = \sqrt{2P}\sin Q, \qquad p = \sqrt{2P}\cos Q$$

(4 x 3 = 12 Weightage)

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