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752102

December 2023

M.Sc. (Physics) 1st SEMESTER

Classical Mechanics (MPH 102)

Time : 3 Hours] [Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART–A

1. (a) Write an expression for Generalized Acceleration. (1.5)

(b) State the condition for a transformation to be canonical. (1.5)

(c) At what speed, the mass density of an object will increase by 25% of its rest mass. (1.5)

(d) What do you mean by center of mass of a system. of particles? (1.5)

(e) What are small oscillations? (1.5)

(f) How many numbers of non-zero frequency normal modes exist for a system of 12 degree of freedom?

(g) Write Jacobi's identity. (1.5)

(h) Prove the law of conservation of angular momentum. (1.5)

(i) Define constraints. Write about Holonomic and non-Holonomic constraints. (1.5)

(j) What do you mean by Lagrange's Bracket. (1.5)

PART–B

2. (a) Setup the Langragian and obtain an expression for Double Pendulum. (7)

(b) What dc you mean by Canonical the expression for 3rd and 4th form of canonical transformation.

3. (a) Define Possions bracket of two dynamical variables. Shows that for any three dynamical variables u, v, w the Jacobi identity [u, [v, w]] + [v, [w, u]] + [w, [u, v]] is satisfied. (5)

(b) Show that

$$Q = \sqrt{(2q)}e^{\alpha} \cos p, \qquad P = \sqrt{(2q)}e^{-\alpha} \sin p$$

is a canonical transformation. (5)

(c) Using Poisson bracket, show that the transformation

$$Q = (e^{-2}q - p^2)^{1/2}$$

$$P = \cos^{-1}(pe^{q}) \text{ is canonical} \quad (5)$$

4. (a) State and prove Virial theorem. (7)

(b) Give an account of Hamilton Jacobi theory a d illustrate it by applying it to the problem of simple hramonic oscillator. (8)

5. (a) State and prove Kepler's third law of planetary motion. (7)

(b) A charged particle is moving under the influence of point nucleus. Find the orbit of the particles and the periodic time in the case of an elliptical orbit. (8)

6. (a) Deduce the Eigen value equation for small oscillations. How will you obtain the Eigen values and Eigen vectors form this equation? (7)

(b) Explain free vibrations of a linear Triatomic molecule. (5)

(c) Two masses m and 3m are attached to the two ends of a massless spring with force constant k. If m 100 g and k = 0.3 N/m, then find the natural angular frequency of oscillations. (3)

7. (a) Derive mass energy equivalence relation. Explain its physical significance. (7)

(b) What are the postulates of Special theory of relativity? Explain time dilation and length contraction. (8)
