PG Odd Semester (CBCS) Exam., December—2017

PHYSICS

(1st Semester)

Course No. : PHYCC–101

(Classical Mechanics)

Full Marks : 70
Pass Marks : 28

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **five** questions, taking **one** from each Unit

UNIT—I

1. What are generalised coordinates? What is d'Alembert's principle of virtual work? Using this principle and Newton's second law, derive Euler-Lagrange equation. 3+3+8=14

2. What are constraints for a dynamical system? Give the examples for one-time independent and one-time dependent constraints. Hence write down the Euler-Lagrange equation for these two constraints.

Give one example of velocity-dependent potential and obtain the Euler-Lagrange equation for a system experiencing electromagnetic force. 1+2+4+7=14

UNIT—II

3. What is the principle of least action? Using this mathematical equation, derive Euler-Lagrange equation.

A particle is falling under gravity through a height x. Obtain the mathematical expression for the path, so that the time taken is minimum. 7+7=14

4. Two particles are under the action of their mutual gravity and separated by a vector r. Obtain the Lagrangian of this system and then show that the vector r traverses a conic section. 6+8=14

UNIT—III

5. Obtain the expression for Legendre's transformation. Use it to obtain the expression for Hamiltonian in terms of the Lagrangian of a system. Hence obtain Hamilton's canonical equation of motion. 3+5+6=14

6. What are Poisson's brackets (PBs)? Obtain the Jacobi's identity in terms of PB.

If u is a constant of motion, then show $[H, u] \quad \frac{u}{t}$. Show that PBs are invariant under canonical transformation. 3+3+8=14

UNIT—IV

7. State and discuss what are Hamilton-Jacobi equations. Using Hamilton-Jacobi method, derive the equation of motion of simple harmonic oscillator. 4+10=14

8. Write down the Hamilton-Jacobi equation for an one-dimensional simple harmonic oscillator and solve it with the initial conditions $q \quad q_0$, and $p \quad 0$ at $t \quad 0$. Find the action variable $J \quad \circ p\,dq$ for the above oscillator and find the oscillator frequency. 10+4=14

UNIT—V

9. Describe the Euler theorem on the motion of a rigid body. Considering infinitesimal rotation, find an expression for the 'rate of change of a vector' in the laboratory frame. Hence derive the expression for Coriolis force. 5+5+4=14

10. Discuss the motion of an one-dimensional chain of n oscillators. What are normal coordinates? Derive the frequencies of free vibration for the above case. 5+2+7=14

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