2021
B.A./B.Sc.
Fifth Semester
DSE – 1
PHYSICS
Course Code: PHD 5.11
(Classical Dynamics)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) State and prove the D'Alembert's principle. 2+5=7
   (b) Derive the Lagrange equations from D'Alembert's principle. 7
2. (a) Formulate the Lagrange's equation of motion for a linear harmonic oscillator and calculate the frequency of oscillation. 5+1=6
   (b) A massless rod is hinged at the extremity of a vertical spring that is fixed to the ground. Find the equation of motion of a harmonic system by formulating its Lagrangian if a mass point rest on the rod. 8

UNIT–II

3. (a) State and deduce the Hamilton's principle. 1+ 7=8
   (b) Formulate the Hamiltonian and the Hamilton's equations of motion for a simple pendulum. 3+3=6
4. (a) A particle is constrained to move on the surface of a transparent cylinder such that it is directed towards the origin and proportional to the distance of the particle from the origin. Formulate the Hamiltonian and the Hamilton's equations of motion. 6
   (b) Calculate the Hamiltonian for a charged particle in an electromagnetic field. 8

UNIT–III

5. (a) Explain with necessary diagrams about stable and unstable equilibrium. Write two differences between them. 4+2=6

(b) Consider a two-coupled oscillator to show that the motion of each coordinate is a superposition of two harmonic vibrations. 8

6. (a) A uniform bar of length L and mass m is supported at the ends by identical springs of elastic constants k. Solve the problem of motion by identifying the normal modes if the motion is initiated by depressing one end by a small distance a and releasing it from rest. 10

(b) A particle of mass 8 *kg* is moving in the potential $v(x) = \frac{1}{2}ax^2 + \frac{1}{4}bx^2$. Calculate the linear frequency of small oscillation about the point of stable equilibrium. 4

UNIT–IV

7. (a) Write two postulates of the special theory of relativity. 2

(b) Derive the Lorentz transformation equation and the Lorentz transformation of space and time in four vector form. 8+4=12

8. (a) Explain Minkowski space, world point, world line, space like, time like, light like and space-time diagram. 10

(b) A spacecraft is contracted to 50 percent of its initial length. What is the speed of the spacecraft? 4

UNIT–V

9. (a) Discuss in detail the relativistic effect of Doppler's effect of light waves. Explain further the blue and red shift in relativistic Doppler effect. 6+4=10

(b) Derive the equation of continuity for liquid. 4

10. (a) Define the rate of flow of a liquid. Derive an expression for the rate of flow of a liquid. 1+3=4

(b) Deduce the Poiseuille's equation for flow of a liquid through a pipe. 6

(c) Calculate the rate of flow of two capillaries of diameters 0.2 *mm* and 0.4 *mm* having lengths 100 *m* and 400 *m* respectively set in series with a constant pressure head of 20 *cm* of water (coefficient of viscosity of water is 0.0089 C.G.S. unit). 4
