2023
B.A./B.Sc.
First Semester
CORE – 2
PHYSICS
Course Code: PHC 1.21
(Mechanics)

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

Answer <u>five</u> *questions, taking* <u>one</u> *from each unit.*

UNIT–I

1. (a) What is Galilean transformation? Obtain Galilean transformation equations.   1+4=5
    (b) Prove that the law of conservation of momentum is invariant under Galilean transformation.   3
    (c) Find the net force and thrust on a rocket.   6

2. (a) What is centre of mass? Find the velocity, acceleration, and linear momentum of centre of mass.   1+2+2+2=7
    (b) Express conservative force as gradient of potential energy and prove that the curl of a conservative force is zero.   4
    (c) At what velocity will a 10,000 kg truck have   3
        (i) the same momentum
        (ii) the same kinetic energy as a 4,000 kg car at 30 m/sec?

UNIT–II

3. (a) Differentiate between elastic and inelastic collision and discuss perfectly inelastic collision in one dimension in laboratory frame.   1+4=5
    (b) Show that torque is the time rate of change of angular momentum and prove that for a rigid body, angular momentum is constant in absence of torque.   4

(c) Find the moment of inertia of a solid cylinder about its own axis of cylindrical symmetry and about an axis through its centre and perpendicular to its axis of cylindrical symmetry. 5

4. (a) Find the moment of inertia of a hollow cylinder about its own axis of cylindrical symmetry and about an axis through its centre and perpendicular to its axis of cylindrical symmetry. 7
   (b) Find the moment of inertia of a solid sphere about its diameter and about a tangent. 5
   (c) A torque of 1 Nm is applied to a wheel of mass 10 kg and radius of gyration 50 cm. What is the resulting acceleration? 2

UNIT–III

5. (a) What is Coriolis force? Discuss its effects. 2+3=5
   (b) Find the gravitational potential and field due to a solid sphere at different points. 9

6. (a) Show how a two body problem is reduced to a one body problem in physics. 3
   (b) Find the orbital speed, time period and height above the Earth's surface of satellites in circular orbit. 8
   (c) A sphere of mass 19 kg is attracted by another sphere of mass 150 kg, when their centres are separated by a distance of 0.28 m with a force equal to the weight of 0.25 mg. Calculate the gravitational constant. If the distance is halved, what would be the new force in Newton? 3

UNIT–IV

7. (a) Prove the relation $Y = 2\eta(1+\sigma)$, where the symbols have their usual meaning in elasticity. Also show that $\dfrac{9}{Y} = \dfrac{1}{K} + \dfrac{3}{\eta}$. 5+2=7
   (b) Derive the expression of torsional rigidity for a solid and hollow cylinder. Compare their torsional rigidities. 5+2=7

8. (a) Obtain the expression of total energy of a simple harmonic oscillator. Also derive the expression of maximum kinetic energy and potential energy. 8

(b) What is damped oscillation? Obtain the differential equation of motion of a damped harmonic oscillator. 4

(c) State Hooke's law and define Poisson's ratio. 2

UNIT–V

9. (a) Describe and discuss Michelson-Morley experiment. 6

(b) Discuss time dilation and explain twin paradox. 4

(c) Show that in relativistic mechanics, addition of any velocity to the velocity of light merely reproduces the velocity of light. What happens when $v << c$? 4

10. (a) Derive Einstein's mass - energy relation and state two examples related to it. 6

(b) Define and explain relativistic Doppler's effect? 6

(c) State the postulates of special theory of relativity. 2

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