

2023
B.A./B.Sc.
First Semester
 GENERIC ELECTIVE – 1
PHYSICS
Course Code: PHG 1.11
 (Mechanics)

Total Mark: 70
Time: 3 hours

Pass Mark: 28

Answer five questions, taking one from each unit.

UNIT-I

1. (a) What is scalar product of two vectors? How is scalar product interpreted geometrically? State the properties of scalar product of vectors. 1+3+3=7
- (b) Discuss the derivative of a vector with respect to position, velocity and acceleration. 4
- (c) Find the angle between the vectors $\vec{A} = 2\hat{i} + 2\hat{j} - \hat{k}$ and $\vec{B} = 3\hat{i} + 4\hat{j} + 5\hat{k}$. 3
2. (a) What is vector product of two vectors? State the properties of scalar product of vectors. Express vector product of two vectors in terms of their rectangular components. 1+2+3=6
- (b) What is centre of mass? Obtain the expression of velocity and acceleration of centre of mass. 1+4=5
- (c) A particle moves from a point (3, -4, -2) m to a point (-2, 3, 5) m under the influence of a force $\vec{F} = (-2\hat{i} + 3\hat{j} + 4\hat{k})$ N. Calculate the work done by the force. 3

UNIT-II

3. (a) Discuss how a two-body problem is reduced to a one-body problem in mechanics. 5

- (b) State and prove the law of conservation of momentum for a one particle as well as two particle system. 4
- (c) What is work? Prove that work done is equal to the product of the component of force along the displacement and the displacement. 5
4. (a) What is kinetic energy? Prove that kinetic energy is equal to $\frac{1}{2}mv^2$ where the symbols have their usual meaning. 1+3=4
- (b) What is a variable mass system? Considering a rocket as a variable mass system, find the net force acting and thrust on the rocket. Obtain the equation of motion of a rocket. 10

UNIT-III

5. (a) Find the gravitational potential and field due to a spherical shell at various points. 10
- (b) State Kepler's law of planetary motion. Calculate the period of revolution of Neptune around the Sun if the diameter of its orbit is 30 times the diameter of Earth's orbit around the Sun. Assume that both orbits are circular. 2+2=4
6. (a) Explain time dilation. What is twin paradox? 3+1=4
- (b) Explain length contraction in relativity. 4
- (c) Write short note on geosynchronous orbit. 3
- (d) A particle with a proper lifetime of $1\ \mu\text{s}$ moves through the laboratory frame at $2.7 \times 10^8\ \text{ms}^{-1}$. What is its lifetime as measured by an observer in the laboratory frame? What will be the distance traversed by it before disintegrating? 3

UNIT-IV

7. (a) Solve the differential equation $(2xy + x^2)dy = (3y^2 + 2xy)dx$. 4
- (b) Write the differential equation of motion of SHM and find its various solutions. 5
- (c) For a particle executing SHM, show that the time-average kinetic energy is equal to the time-average potential energy. 5

8. (a) Obtain the differential equation of motion of a damped harmonic oscillator and find its general solution. 9
- (b) What is a bar pendulum? Derive the expression of time period of a bar pendulum. 5

UNIT-V

9. (a) Prove the relation $Y = 3K(1 - 2\sigma)$, where the symbols have their usual meaning. 5
- (b) Obtain the expression for twisting couple of a hollow cylinder and compare it to that of solid cylinder. 6
- (c) Calculate η and σ for silver. Given that $Y = 7.25 \times 10^{11}$ dynes/cm² and $K = 11 \times 10^{11}$ dynes/cm². 3
10. (a) What is viscosity? Derive Newton's law of viscous force. 1+4=5
- (b) Describe molecular theory of surface tension. 5
- (c) What is surface energy? How is it related to surface tension? 1+3=4
