

2025

(November-December)

**PHYSICS**

Paper: PHY-M-101

**Mechanics & Relativity****Time: 2½ Hours****Total Mark: 60****Pass marks: 18***(The figures in the right margin indicate full marks of the questions)*

1. Choose the correct answer 1×6=6
- (a) The divergence of a constant vector field is—  
 (i) Zero (ii) Constant  
 (iii) Infinite (iv) Depends on coordinates
- (b) The Galilean transformation fails for  
 (i) Low speeds (ii) Rotational motion  
 (iii) Electromagnetic waves (iv) Uniform motion
- (c) The Poisson ratio for an ideal incompressible material is  
 (i) 0 (ii) 0.25  
 (iii) 0.5 (iv) 1
- (d) The moment of inertia of a solid cylinder about its central axis is  
 (i)  $MR^2$  (ii)  $\frac{1}{2} MR^2$   
 (iii)  $\frac{2}{5} MR^2$  (iv)  $\frac{3}{5} MR^2$
- (e) In a damped oscillation, the energy of the system decreases  
 (i) Linearly (ii) Exponentially  
 (iii) Quadratically (iv) Sinusoidally
- (f) A spaceship moving at relativistic speed will appear  
 (i) Longer (ii) Shorter

- (iii) Unchanged                      (iv) Heavier
2. The force  $\vec{F}$  and displacement  $\vec{D}$  of a particle are given by  
 $\vec{F} = (2\hat{i} + 3\hat{j} + 5\hat{k})$  Newton  $\vec{D} = (\hat{i} + 2\hat{j} + 3\hat{k})$  metre. Evaluate  
the work done. 3
3. Explain why Galilean transformations are linear. 2
4. a) Define shear modulus and Poisson ratio. 2

**Or**

- State the relation between elastic constants Y,  $\eta$  and Poisson's ratio  $\sigma$ ; and explain the physical significance of  $\sigma$  and
- b) What is elasticity? State the relation between the elastic constant, Y, K and  $\eta$  1+1=2
5. State and prove the work-energy theorem for a variable force. 2
6. Derive an expression for the time-averaged total energy of a harmonic oscillator. 2
7. State the postulate of the special theory of relativity. 2

**Or**

Differentiate between inertial and non-inertial frames of reference with one example each.

8. Derive the relativistic mass variation  $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$  4
9. Derive the equation for the motion of the center of mass of a system of particles. 3
10. (a) Derive Poiseuille's equation for the viscous flow of a liquid through a capillary tube. 4
- (b) Write the relation between surface tension and surface energy. 1
11. (a) Deduce the expression for the kinetic energy of Relation for a rigid body. 3

- (b) Calculate the moment of inertia of a solid sphere about its diameter. 4
- (c) Discuss the physical significance of moment of inertia. 2
12. (a) Show that the force acting on a particle is the negative gradient of potential energy. 3
- (b) Discuss the work done by non-conservative forces. 3
13. Derive the equation of damped harmonic oscillator. 5
- 14.(a) Using Lorentz transformations, derive the formula for time dilation. A clock moves at  $0.8c$ . If it measures 10s, find the time interval seen by a stationary observer. 4+3=7

**Or**

- (b) Explain Michelson Morley experiment and mention its outcome. 5+2=7

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